Concurrent Dual Radio 300Mbps WiFi

High Power Outdoor System

User Manual

January, 2015

Revision History

Date	**Notes**
July, 2014	Firmware v5.4.2
October,2014	Firmware v5.5.0 (memory size increase)
January, 2015	Firmware v5.6.1 (user isolation for 2.4GHz & 5GHz AP modes)

Introduction

The MIMO 2x2 Wireless Outdoor System (**"outdoor unit"** in the following paragraphs) consists of two concurrent running radios, one at 5GHz supporting 802.11a/n standard, and the other at 2.4GHz for 802.11b/g/n features. This outdoor AP supports Point-to-Point and Point to Multipoint communication, that the data rate is up to 150Mbps in HT-20 mode, or to 300 Mbps in HT-40 mode. The 5GHz Bridge function is most suitable for enterprises, campus or off-site locations that require LAN or Internet access without the availability of wired networks to extend network coverage up to 35Km.; and the 802.11 b/g/n radio is mainly for Access Point application to provide local wireless access to the Internet, while 5GHz also support Access Point mode.

The outdoor unit offers different encryption mechanisms including WEP, and AES to ensure the communication security. For APs / Bridges connections, the MAC address authentication mechanism is provided.

The outdoor unit is designed for the outdoor environment and it is weatherproofed against the most stringent condition. For further protection, the bridge and Power over Ethernet adapter are all with the built-in lightning protectors.

Its weatherproofed enclosure includes brackets for attaching to a wall, pole, radio mast, or tower structure. The unit powered through its Ethernet cable connection from a power injector module that installed indoors. The wireless bridge system offers a fast, reliable, and cost-effective solution forconnectivity between remote Ethernet wired LANs or to provide Internet access to an isolated site. The system is also easy to install and operate, ideal for situations where a wired link may be difficult or expensive to deploy.

Key Features:

- 2x2 MIMO for both 5GHz (802.11n/a) and 2.4GHz (802.11n/b/g) Radios Platform
- High speed Wire and Wireless connectivity
- 300Mbps 802.11n/a Backhaul and AP functions, 802.11n/b/g AP function
- IP68 rated enclosure for dust and water protection
- Wide operating temperature: -40^{o}C to +60^{o}C
- Built-In lightning protection circuits

Manual Conventions

Bold	Bold type within paragraph text indicates commands, files names, directory names, paths, output, or returned values.
Italic	Within commands, italics indicate a variable that the user must specify. Titles of manuals or other published documents are also set in italics.
Courier	The courier font indicates output or display.
[]	Within commands, items enclosed in square brackets are optional parameters or values that the user can choose to specify or omit.
{}	Within commands, item enclosed in braces are options from which the user must choose.
|	Within commands, the vertical bar separates options.
…	An ellipsis indicates a repetition of preceding parameter.
>	The right angle bracket separates successive menu selection.

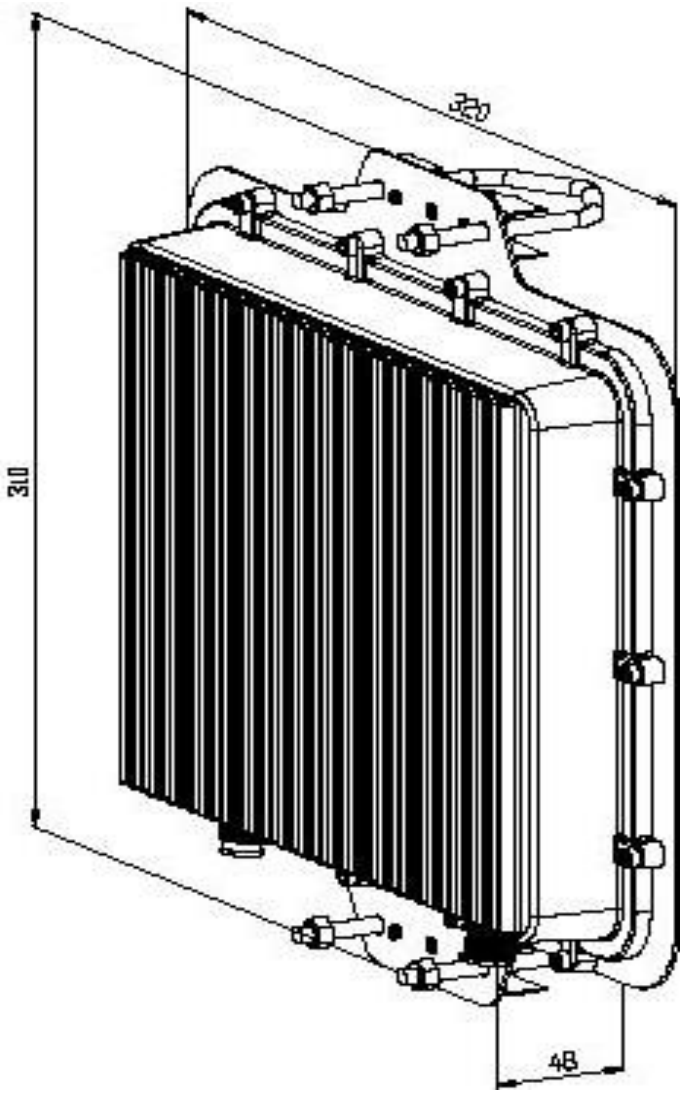
NOTE: This message denotes neutral or positive information that calls out important points to the text. A note provides information that applies only in special cases.

Caution: Cautions call special attention to hazards that can cause system damage or data corruption, to a lesser degree than warnings.

Warnings: Warnings call special attention to hazards that can cause system damage, data corruption, personal injury, or death.

1. MIMO 2x2 Wireless Outdoor Access Point System Hardware Feature

1.1 Hardware Outline (ALINK-A300n)



1.2 Hardware Outline (APRO-A300n)

Product Features

- **Range** — the outdoor unit has been refined and optimized for long range application, up to 35Km.
- **Temperature** — the outdoor unit was tested for normal operation in the ambient temperatures from -40°C to 60°C. Operating in temperatures outside of this range may cause the unit malfunctioned.
- **Wind Velocity**— the outdoor unit can operate in winds up to 90mph and survive higher wind speeds up to 125mph. You must consider the known maximum wind velocity and direction at the site and be sure that any supporting structure, such as a pole, mast, or tower, built to withstand this force.
- **Lightning** — the outdoor unit includes lightning protection circuits inside. However, you should make sure that the unit, any supporting structure, and cables are all properly grounded. Additional protection using lightning rods, lightning arrestors, or surge suppressors may also employed.
- **Rain** — the weather plays one of major matters to the antenna performance for the wireless communication. The raining day, the lightning day, the cloudy day, or the windy day will make a quite big impact to both side antennas over the communication results. It will also affect the communication quality. The outdoor unit is a weatherproofed outdoor unit, which can operate in extremely weather environment. You may need to use the sealing tape around the external antenna port connectors for extra protection. If moisture enters the connector, it may cause degradation in performance or even a complete failure of the link.

Feature Highlight

5GHz 802.11a/n based Point-to-Point Bridge and access point mode

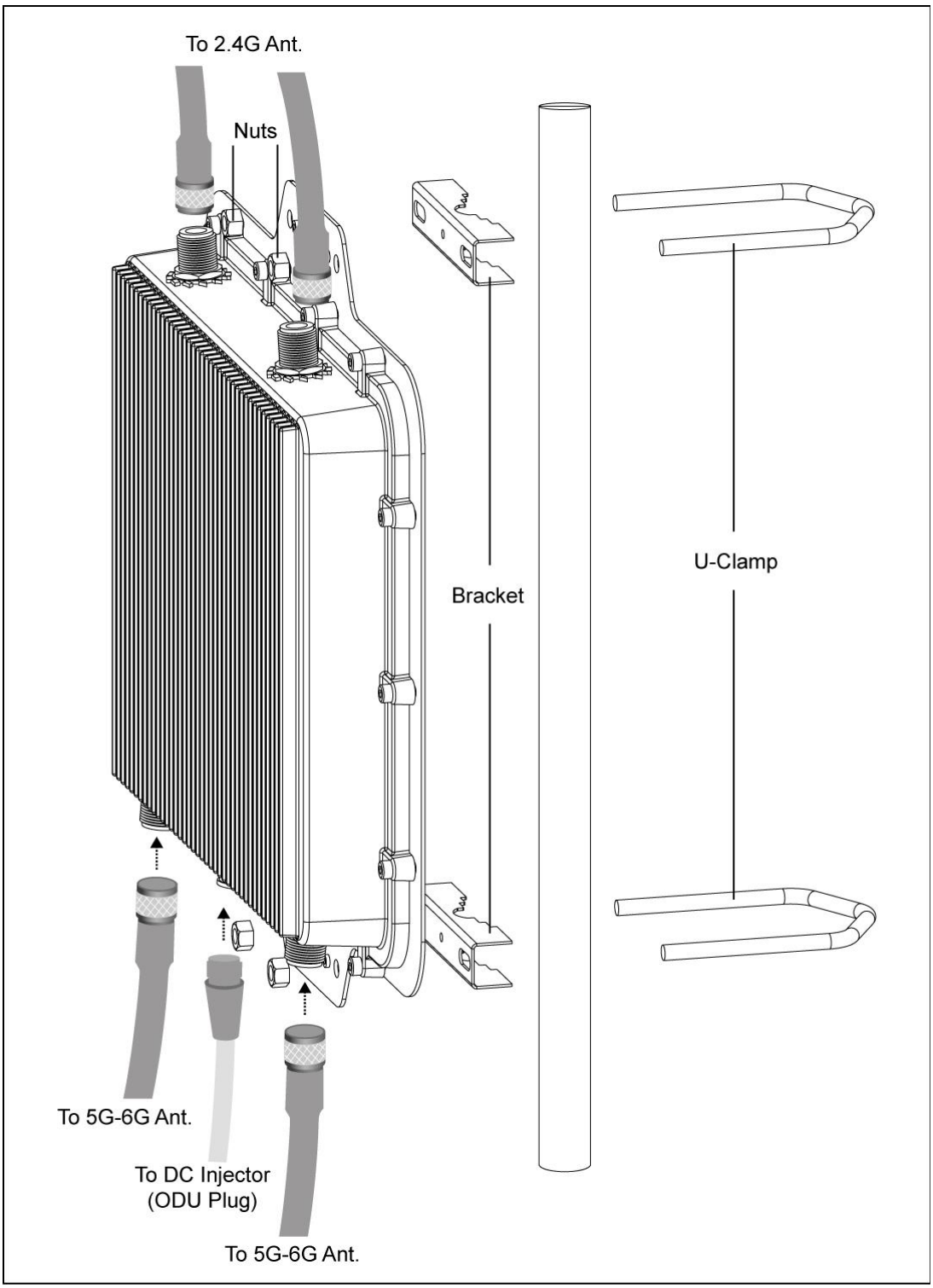
5GHz 802.11a/n based Point-to-Multipoint Bridge (up to 8 links) mode

2.4GHz 802.11b/g/n based high capacity access point mode

1.3 Interface

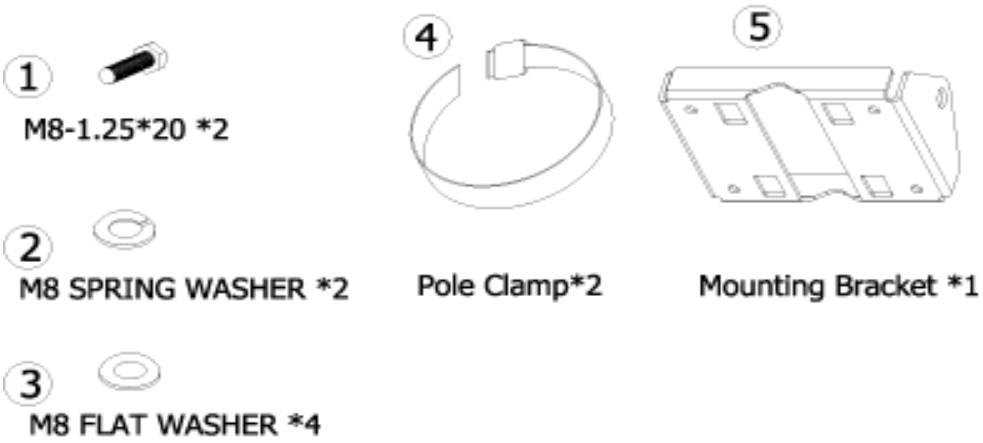
1.3.1 External Antenna Connection:

ALINK-A300n

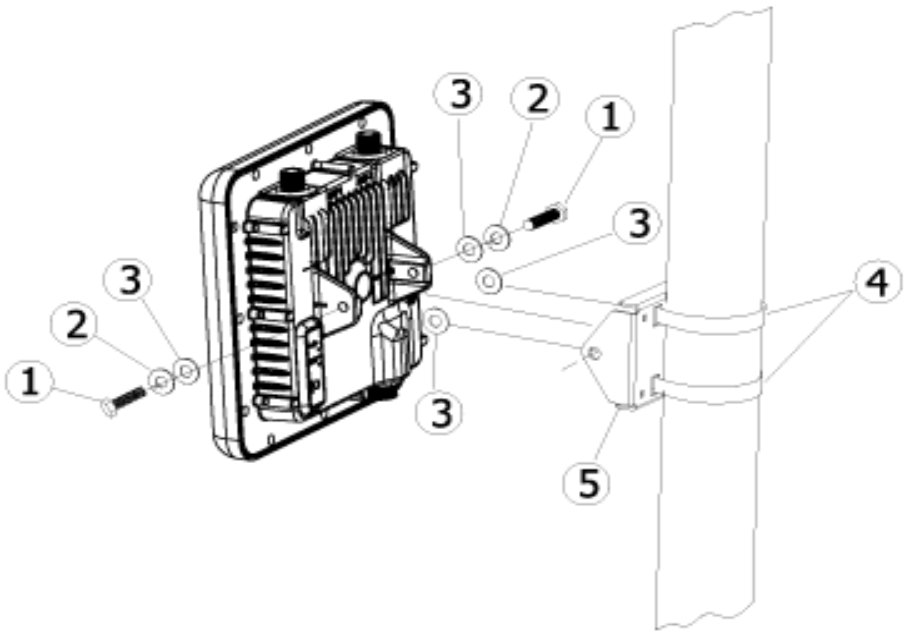


1.3.2 Hardware Installation Guide :

APRO-A300n



*Note: Pole Clamp for
⌀1.2"~2.5" pole

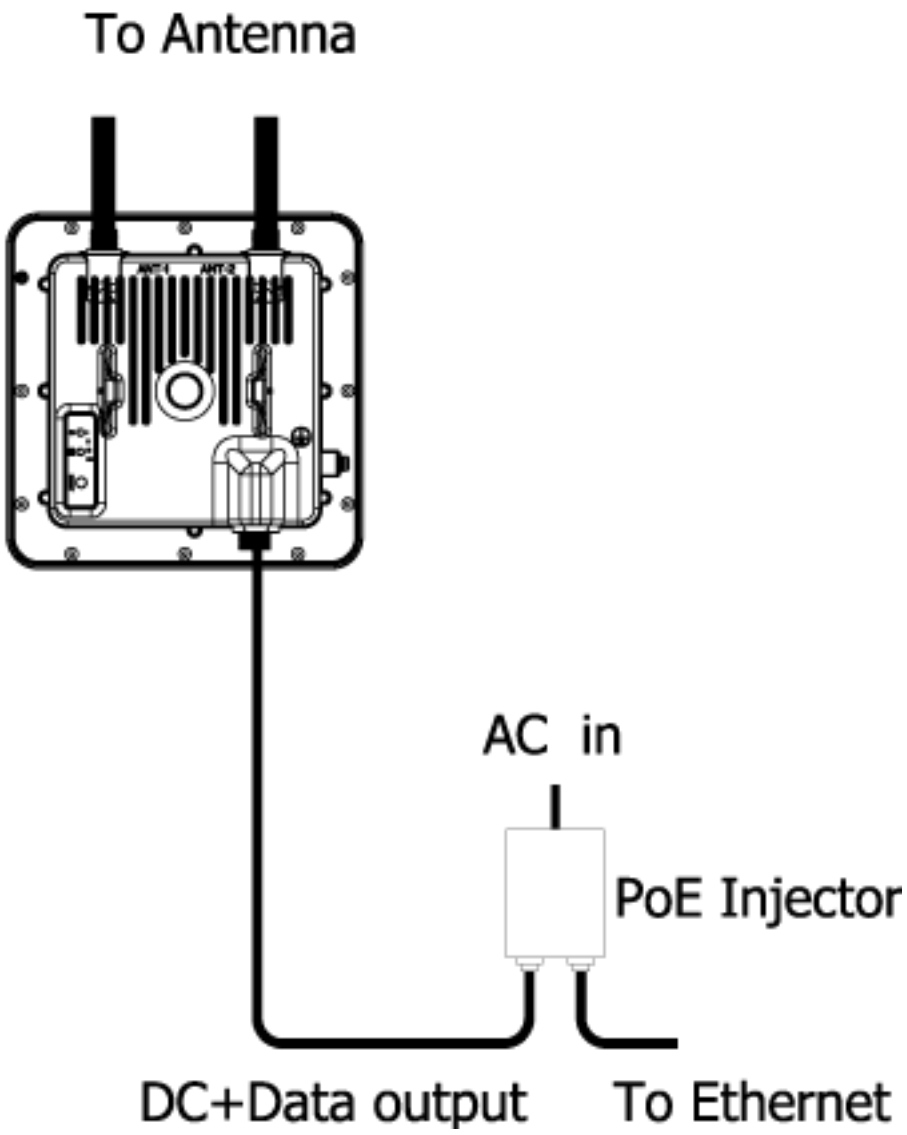


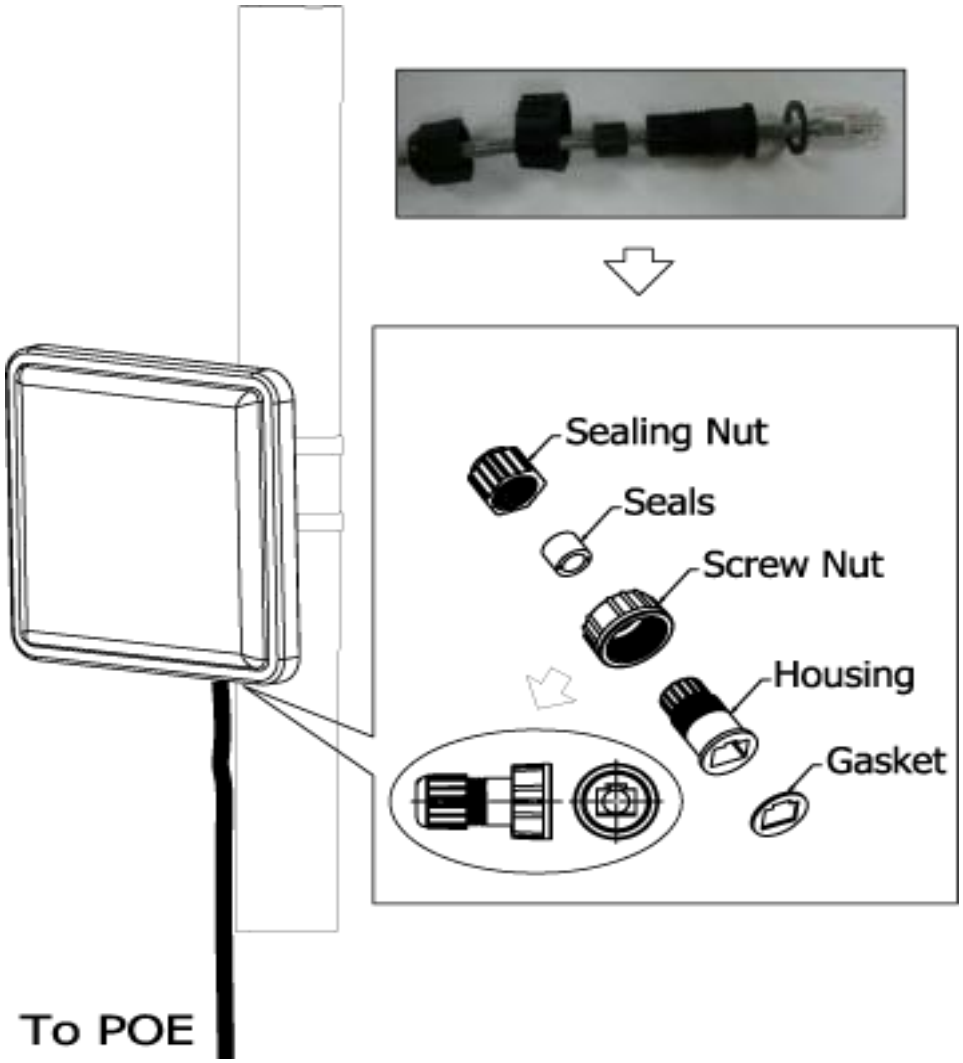
Installation Procedure

Step 1 Fasten the WLAN ODU on the pole with the Mounting Bracket and bolt.

Step 2 Install weather-proof CAT-5e cable between Ethernet port of WLAN ODU & "DC+Data output" port of POE Injector.

Step 3 Install CAT-5e cable to "To Ethernet" port of POE Injector.





1.3.3 Power over Ethernet (PoE) & Cable Connection

PoE Ethernet Cable connects to Output port and link to Outdoor Unit
Ethernet cable connects to Input port and link to host PC or LAN Device (ex. Switch or Hub)

1.3.4 Grounding

1) Proper grounding is always recommended for the safety consideration.

1.4 Product Warranty

This product warranted against defects in materials and workmanship for a period of one year from the date of shipment. If the customer wants to have or extend longer warranty period, please contact the sales for extended warranty. During the warranty period, the defective product will be repaired or to be replaced.

1.5 Warranty Limitation

The foregoing warranty shall not apply to defects resulting from improper or inadequate maintenance by buyers, buyer-supplied software, interfacing, unauthorized modification, inappropriately use, operation out of the product environment specifications, or improper site preparation and maintenance.

1.6 System Requirement

- Windows 2000, XP, Vista Home Basic or Windows 7, Windows 8
- Microsoft Internet Explorer 5.5 or above versions and Google Chrome

1.7 Feature Summary

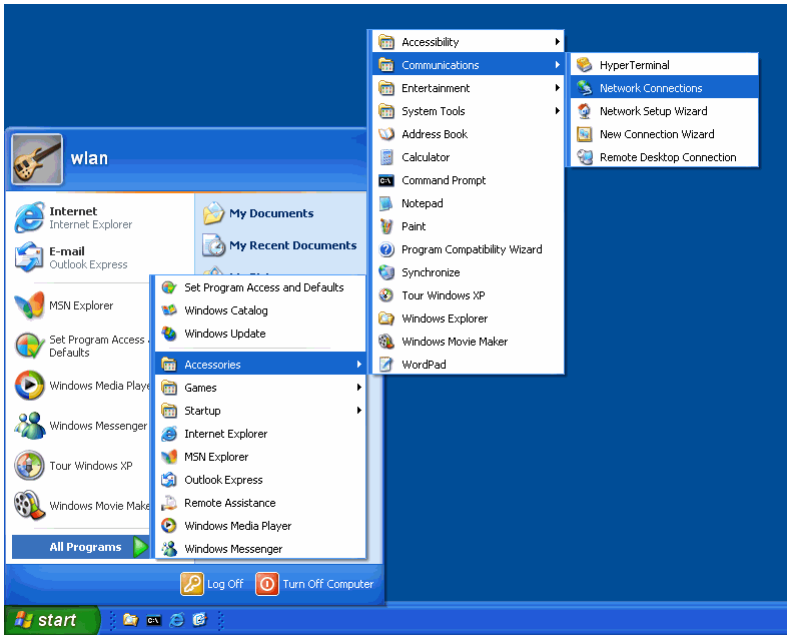
- Provide the Ethernet to Wireless LAN Bridge, or the Ethernet to Wireless LAN Access Point, fully IEEE 802.3 compatible Ethernet interface
- Support 10/100/1000 Base-T Ethernet interface
- The operating mode is IEEE 802.11a/n & 802.11b/g/n infrastructure for the outdoor unit
- The dynamic data rate switching among the standards of 802.11a, 802.11b, 802.11g, 802.11n HT 20, and 802.11n HT40- and 802.11n HT 40+ are provided by ***Atheros*** chipset. The auto fallback feature of data rate capability optimizes the reliability, throughput and transmission range
- Using Web UI to upgrade the firmware

2. Getting Started

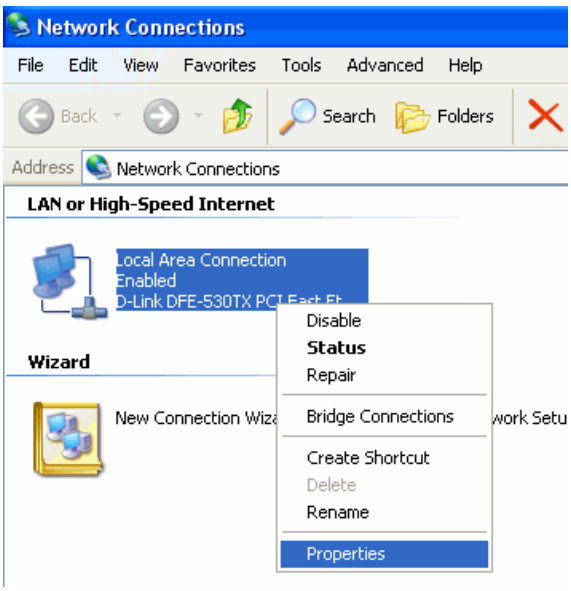
2.1 Setup Local Area Connection on your PC

2.1.1 Start Network Configuration on your PC

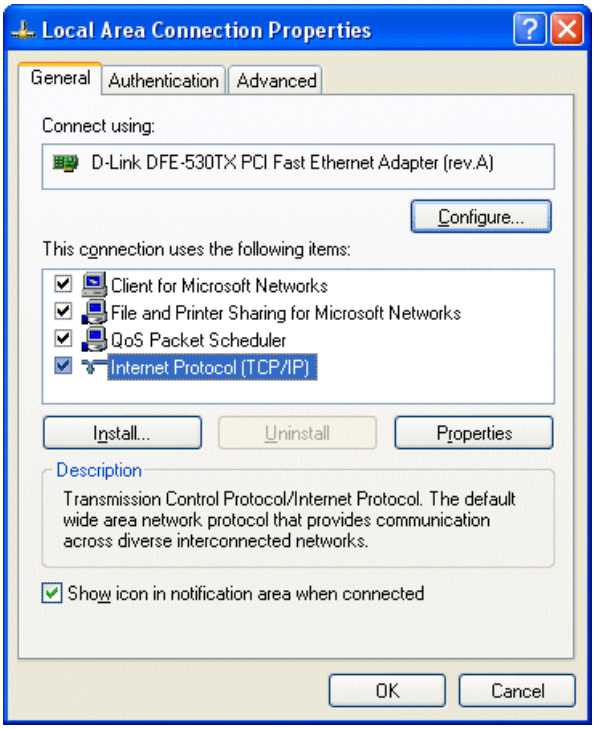
1) Click **Start** > **All Programs** > **Accessories** > **Communications** > **Network Connections**



2) Right click on the **Local Area Connection** and select **Properties**



3) The following window shows up



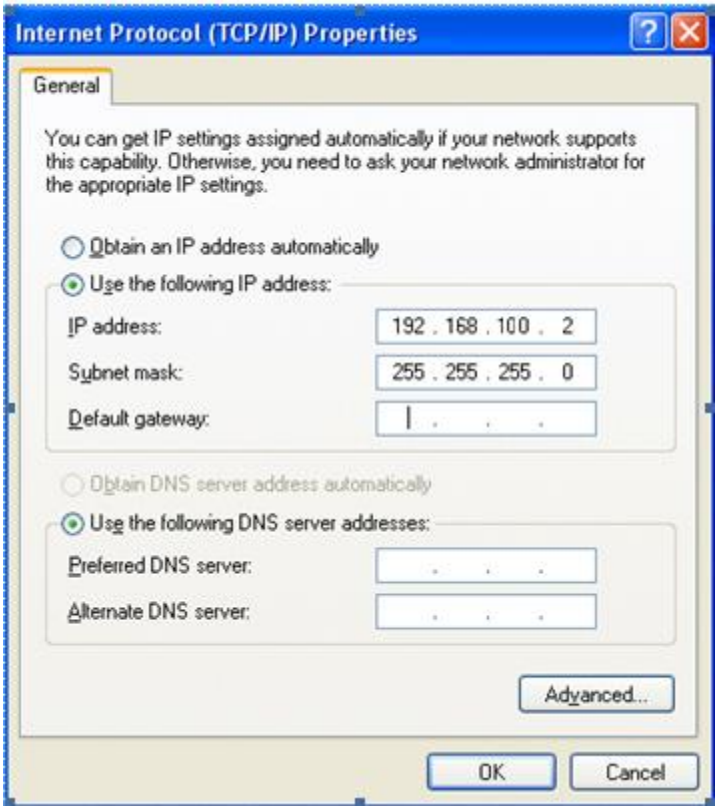
4) Click **Internet Protocol (TCP/IP)** and then **Properties** (or double click on **Internet Protocol (TCP/IP)**)

5) Enter an **IP address** (ex. 192.168.100.2) under the same subnet as the Default IP Address of outdoor unit (**192.168.100.20**)

6) Enter **255.255.255.0** as Subnet Mask

7) Keep the **Default Gateway** and **DNS Server Address** as blank

8) Click **OK** when you finish above settings


Internet Protocol (TCP/IP) Properties
General
You can get IP settings assigned automatically if your network supports this capability. Otherwise, you need to ask your network administrator for the appropriate IP settings.
Obtain an IP address automatically
Use the following IP address:
IP address:
192 . 168 . 100 . 2
Subnet mask:
255 . 255 . 255 . 0
Default gateway:
Obtain DNS server address automatically
Use the following DNS server addresses:
Preferred DNS server:
Alternate DNS server:
Advanced...
OK
Cancel

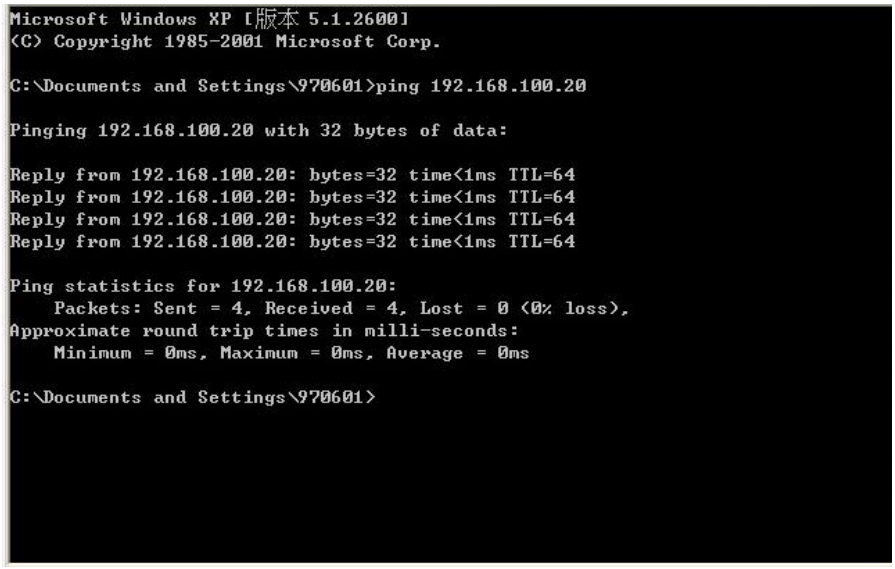
2.2 Check access to the unit

Use **Ping** command of DOS mode to check the access to the outdoor unit.

1) Go to **DOS** mode

2) Enter the command:
   ping 192.168.100.20
   The outdoor unit shall respond your ping request.

Note that use the same PC to ping different outdoor units may cause ping failure. This is because the all of the outdoor units share the same default IP address but different MAC addresses. To prevent from ping failure, you need type command arp –d to clear ARP table on PC before each ping.


Microsoft Windows XP [版本 5.1.2600]
(C) Copyright 1985-2001 Microsoft Corp.
C:\Documents and Settings\970601>ping 192.168.100.20
Pinging 192.168.100.20 with 32 bytes of data:
Reply from 192.168.100.20: bytes=32 time<1ms TTL=64
Reply from 192.168.100.20: bytes=32 time<1ms TTL=64
Reply from 192.168.100.20: bytes=32 time<1ms TTL=64
Reply from 192.168.100.20: bytes=32 time<1ms TTL=64
Ping statistics for 192.168.100.20:
Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
Minimum = 0ms, Maximum = 0ms, Average = 0ms
C:\Documents and Settings\970601>

2.3 Access to web pages

1) Launch a Web Browser

2) Enter the default IP address as URL (default IP address: **192.168.100.20**) and the initial home page (login page) will appear

3) Enter user name (default username: **Admin**) and password (default password: **Wireless**)

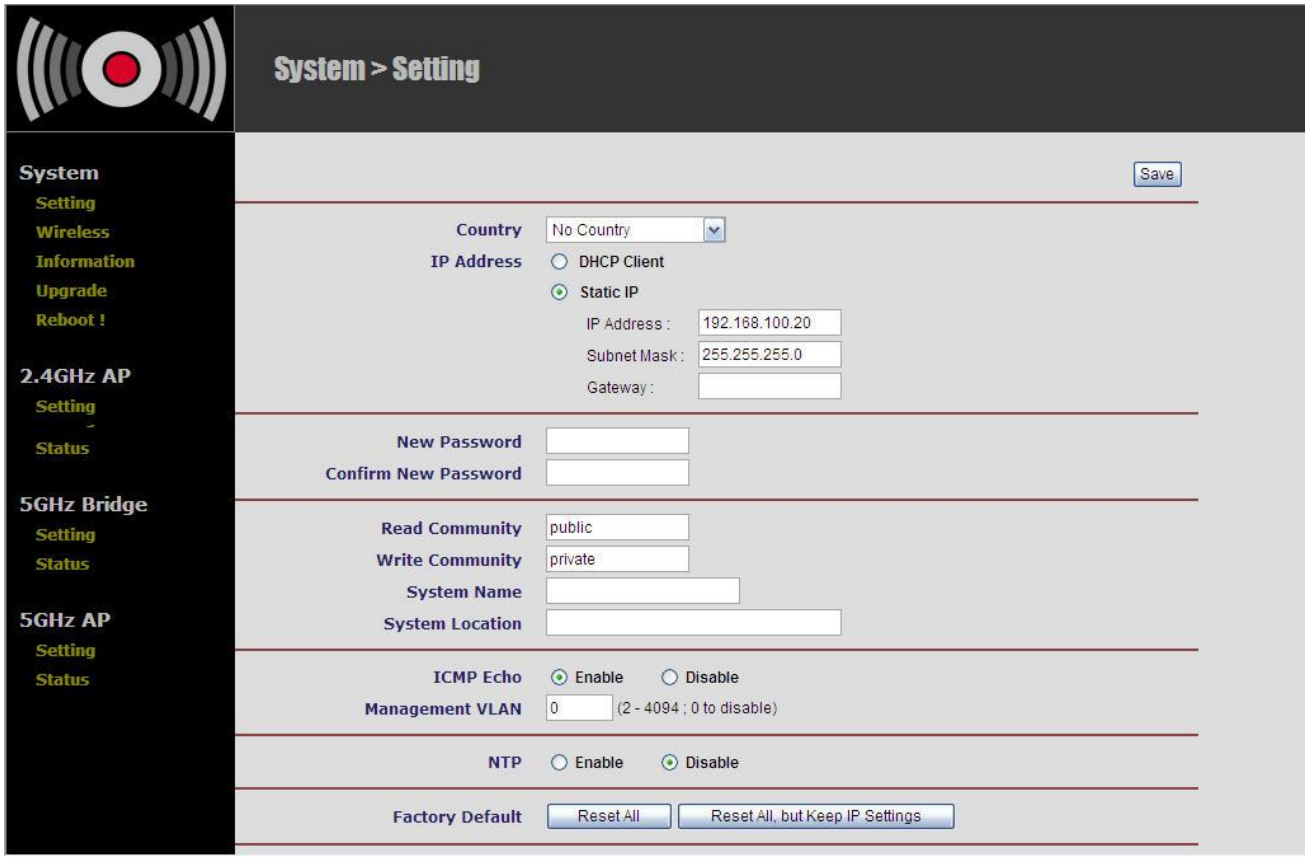
Note: You need to use the default user name and password when you log in for the first time.

4) The **System Setting** page will come up after you log in successfully

2.4 Basic Configuration

2.4.1 System Setting

This page can be accessed by clicking **System** > **Setting**.



1) **Country**

You can set the AP to follow different country and region regulation.

2) **IP Address**

DHCP Client

Select this if your Internet Service Provider (ISP) uses a DHCP service to assign an IP address to your router when connecting to the Internet.

Static / Subnet Mask / Gateway

Note that each outdoor unit in the same network must be assigned with an unique IP address. Therefore, you may need to have a network plan before deployment. Enter the IP address, Subnet Mask according to the plan. Changes of IP Address / Subnet Mask will be applied after you click **Save**.

3) **Password**

Change **Password** by entering a new password twice, click **Save** and then **Reboot**. User will be

asked to login again with new password after reboot (the password is case sensitive).

4) **SNMP Community**

SNMP Community name is a string for administrator to read and write the SNMP MIB from external SNMP manager. The default SNMP community name is **public** for read community, and **private** for write community. You may change the community name as your plan. Confirm your setup then clicking **Save** to perform.

5) **System Name & Location**

The fields of System Name and System Location is the strings for you to conveniently identify the different unit. The content of the string is empty by default and can be any ASCII characters with max. length of 255 characters for both System Name and System Location. Confirm your setup then clicking **"Save"** button to perform.

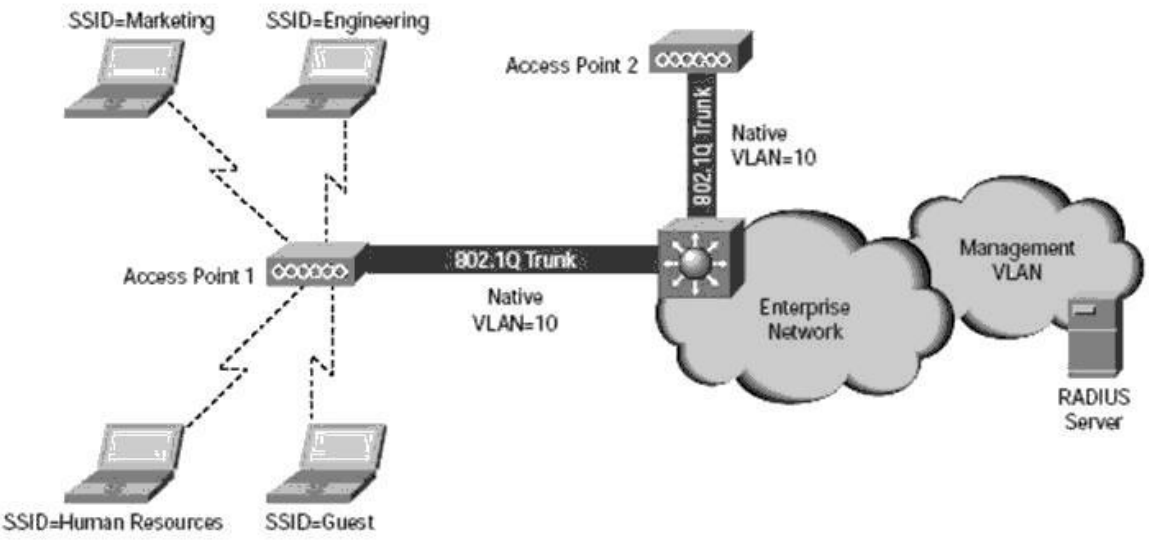
6) **ICMP Echo**

By default, the value is **Enable**. **Ping** is a computer network administration utility used to test the reach ability of a host on an Internet Protocol (IP) network and to measure the round-trip time for messages sent from the originating host to a destination computer. The name comes from active sonar terminology.

Ping operates by sending Internet Control Message Protocol (ICMP) echo request packets to the target host and waiting for an ICMP response. In the process, it measures the time from transmission to reception round-trip time and records any packet loss. The results of the test are printed in the form of a statistical summary of the response packets received, including the minimum, maximum, and the mean round-trip times, and sometimes the standard deviation of the mean.

7) Management VLAN

By default, the values **0** indicates **Disable**. If you have enabled VLAN tagging on your network, specify the VLAN tag ID from 2 to 4094. You can assign an SSID to a VLAN. Client devices using the SSID are grouped in that VLAN



8) **NTP**

The Network Time Protocol (NTP) is a protocol and software implementation for synchronizing the clocks of computer systems over packet-switched, variable-latency data networks. The available NTP server IP & its availability can be found by the following hyperlink (http://www.pool.ntp.org/en/). Enable this feature and specific the IP address of NTP server IP to get the system date & time through NTP protocol.

Time zone: specify the time zone that the product located. This setting is based on the GMT (Greenwich Mean Time).

Daylight Saving Time: Many countries, and sometimes just certain regions of countries, adopt daylight saving time (DST) during part of the year. It needs to enable or disable based on the product located countries or area.

Confirm your setup then clicking **Save** to perform.

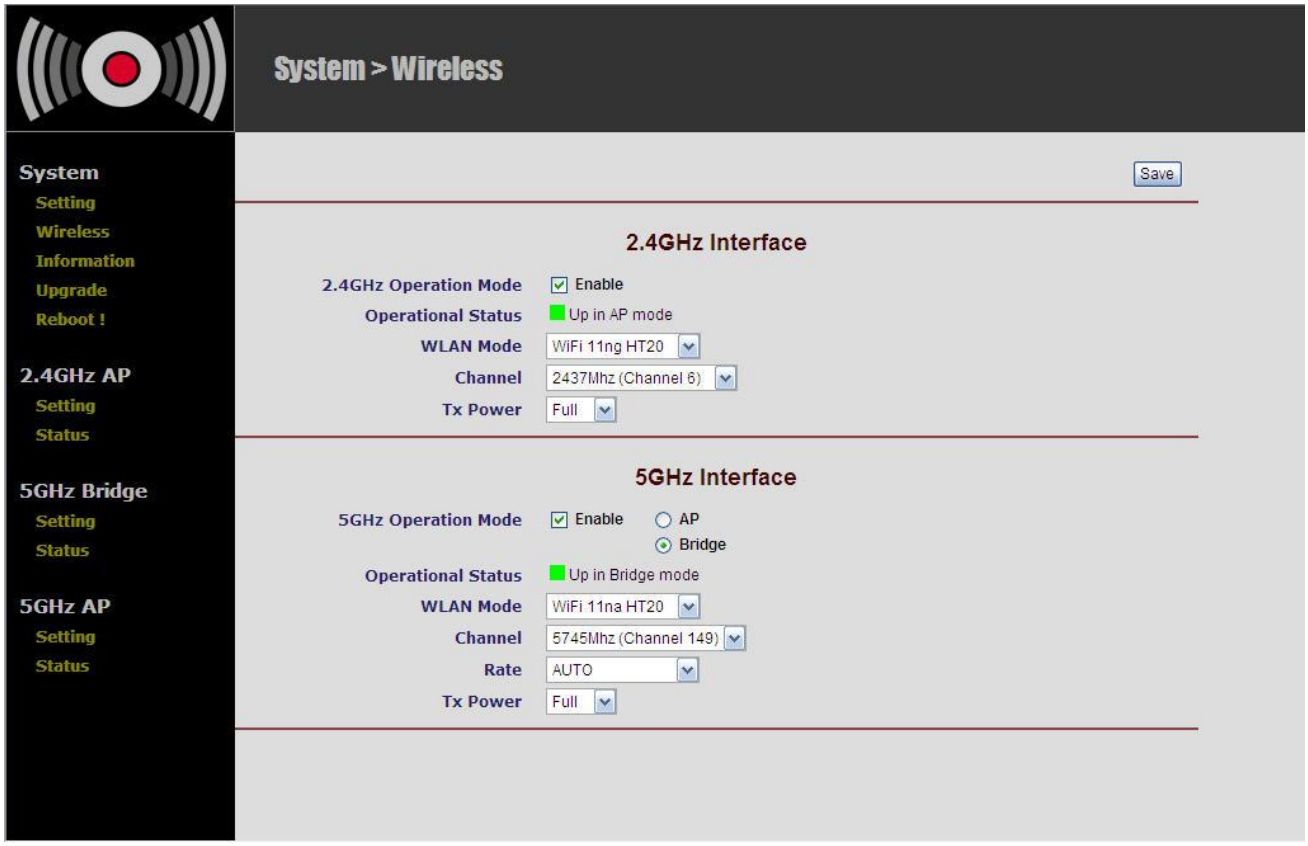
9) **Factory Default**

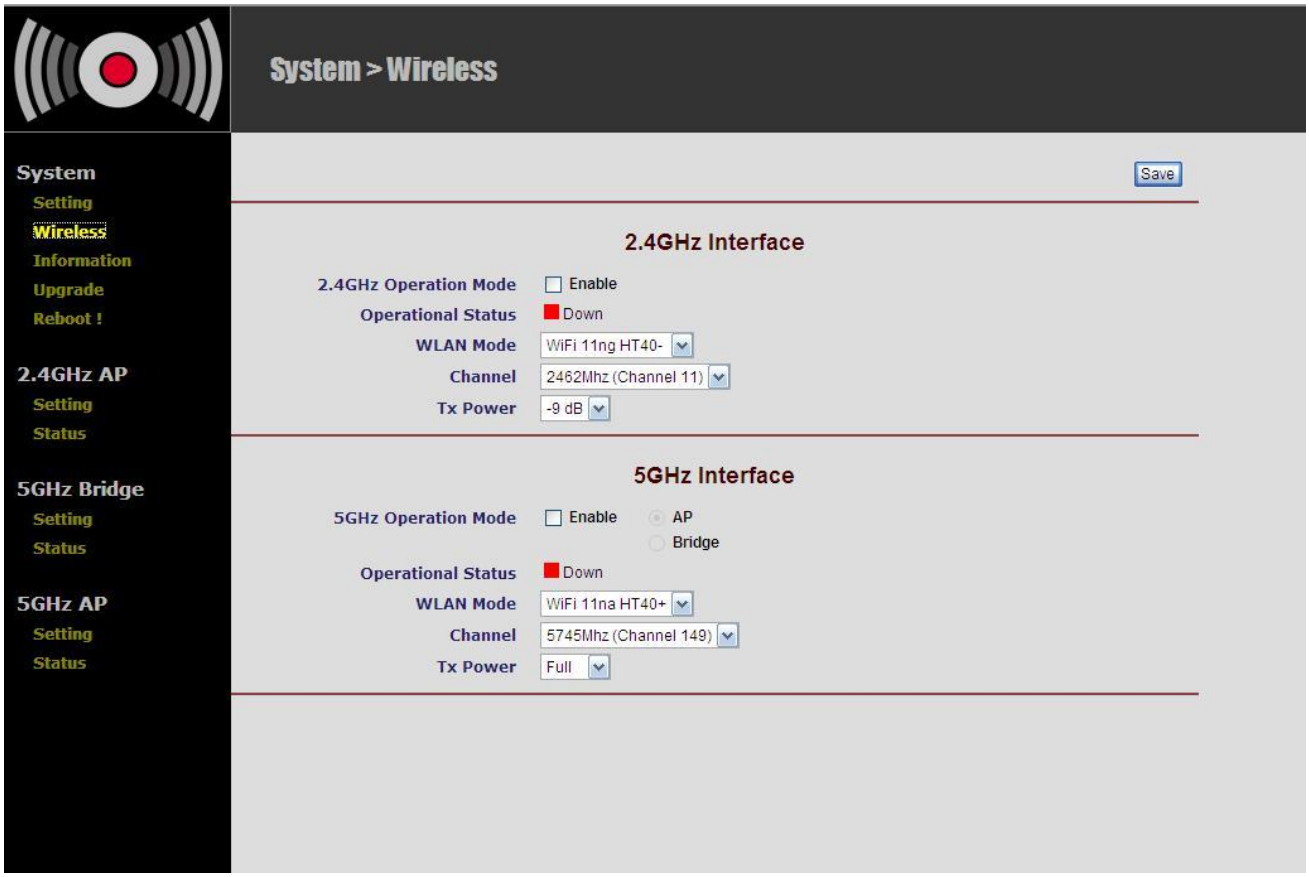
Reset All indicates all the settings will return to default value. **Reset All, but Keep IP Settings** indicates the IP setting stays and other setting return to default.

Note: Clicking **Save** will only save your settings on the unit, make sure you click **Reboot** to make settings effective.

Wireless

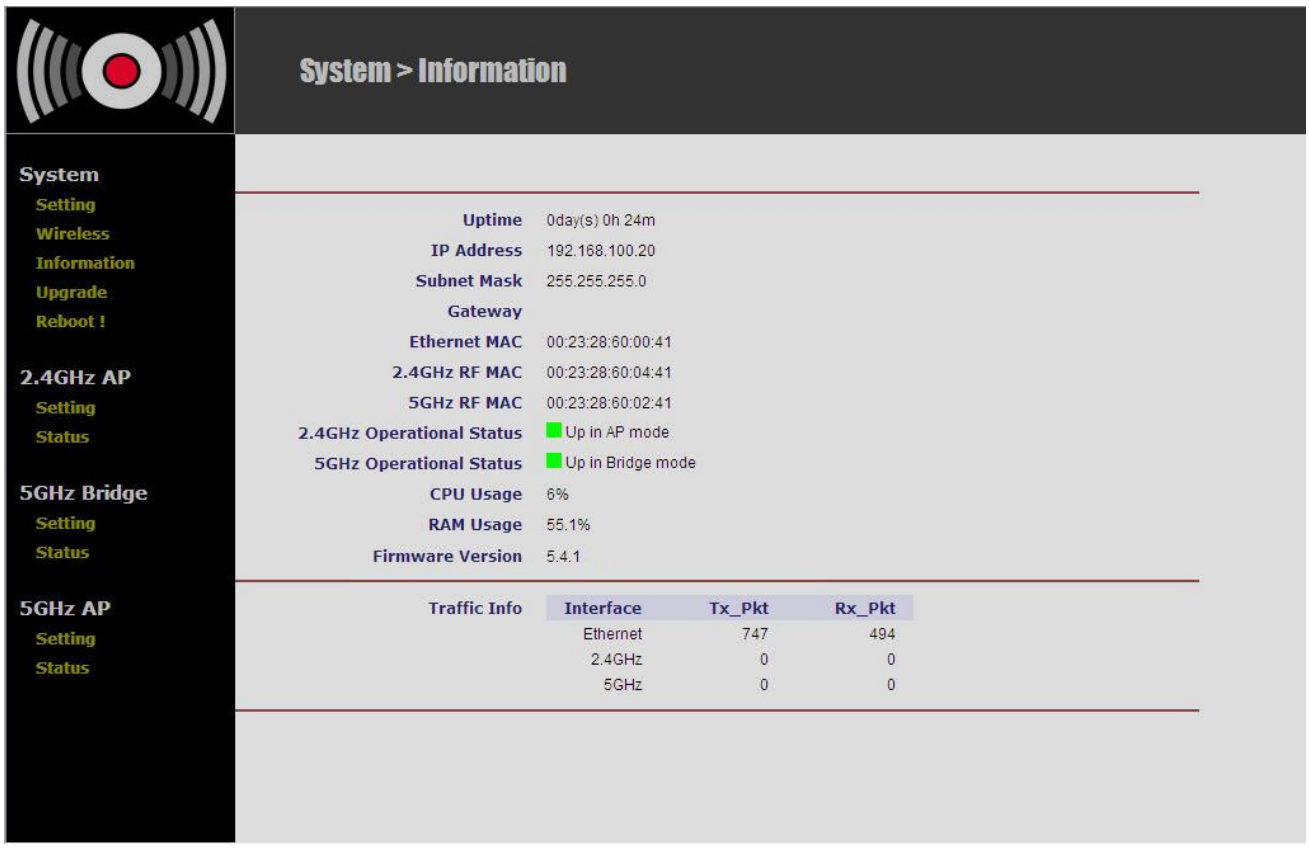
Here, you can configure the operation modes for 2.4GHz (AP to be enabled or disabled) and 5GHz to be AP or Bridge enabled or disabled. Also, you may select the channels, Tx power and WLAN modes according to your network plan.





2.4.2 System Information

This page can be accessed by clicking **System** > **Information**.



This page lists the important system information and software / hardware inventory data.

1) **Uptime**

The elapse time since outdoor unit powered up.

2) **IP address / Subnet Mask / Gateway**

The IP address / Subnet Mask / Gateway of the wireless unit setting.

3) **Ethernet, 5GHz & 2.4GHz RF MAC**

The MAC address of Ethernet and wireless interface.

4) **Firmware Version**

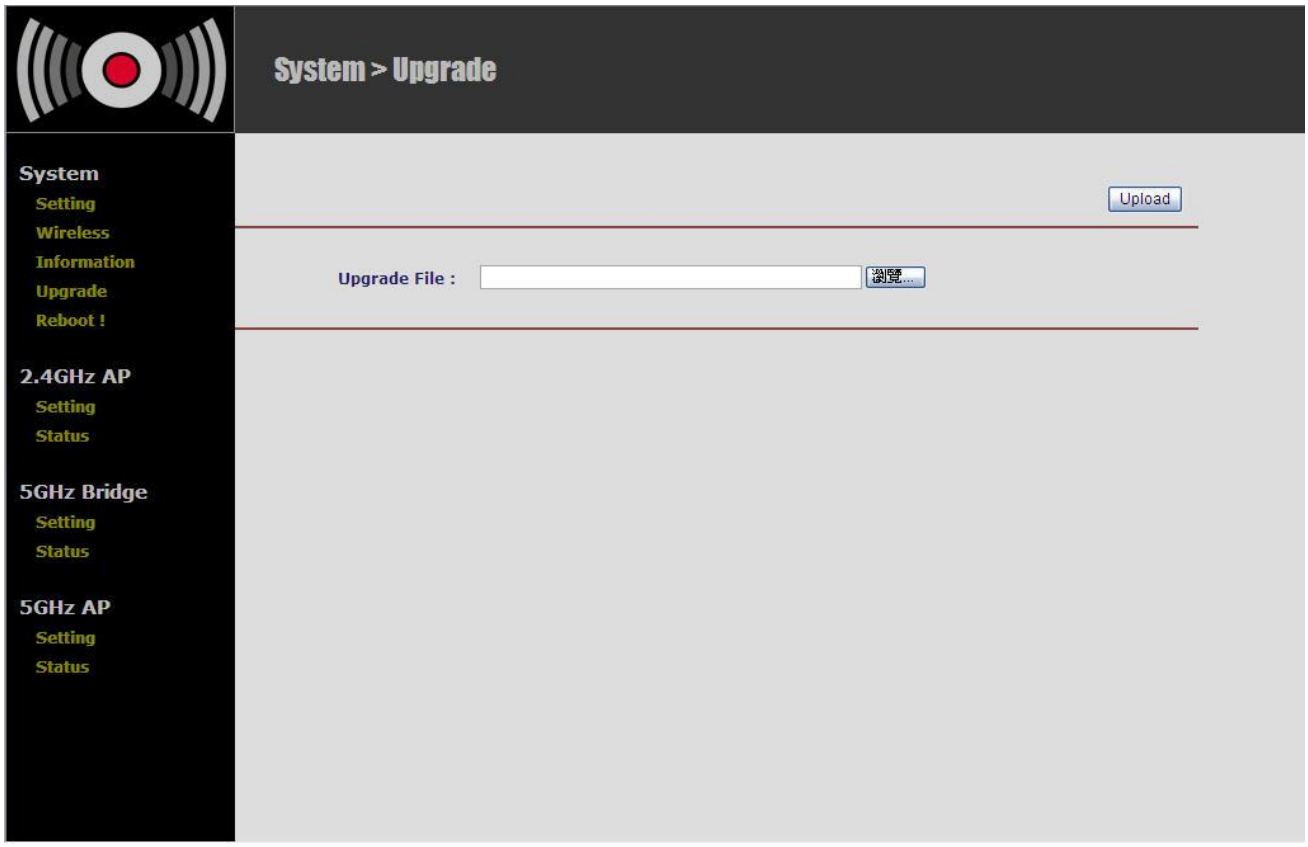
The current firmware version running on the outdoor unit.

5) **Traffic Info**

The statistic data for the packets transmitted by Ethernet and the wireless interfaces.

2.4.3 Upgrade

The reboot function can be apply by clicking **System -> Upgrade** from left side menu



When the new version of firmware has been received, you can upload the file by the web interface for upgrade the firmware. The page can be access by clicking **System -> Upgrade** from the left side menu.

Note:

(a). Before upload the new version of firmware, please read the new firmware release note to confirm the new firmware features, upgrade environment, and procedures can meet the upgrade requirements.

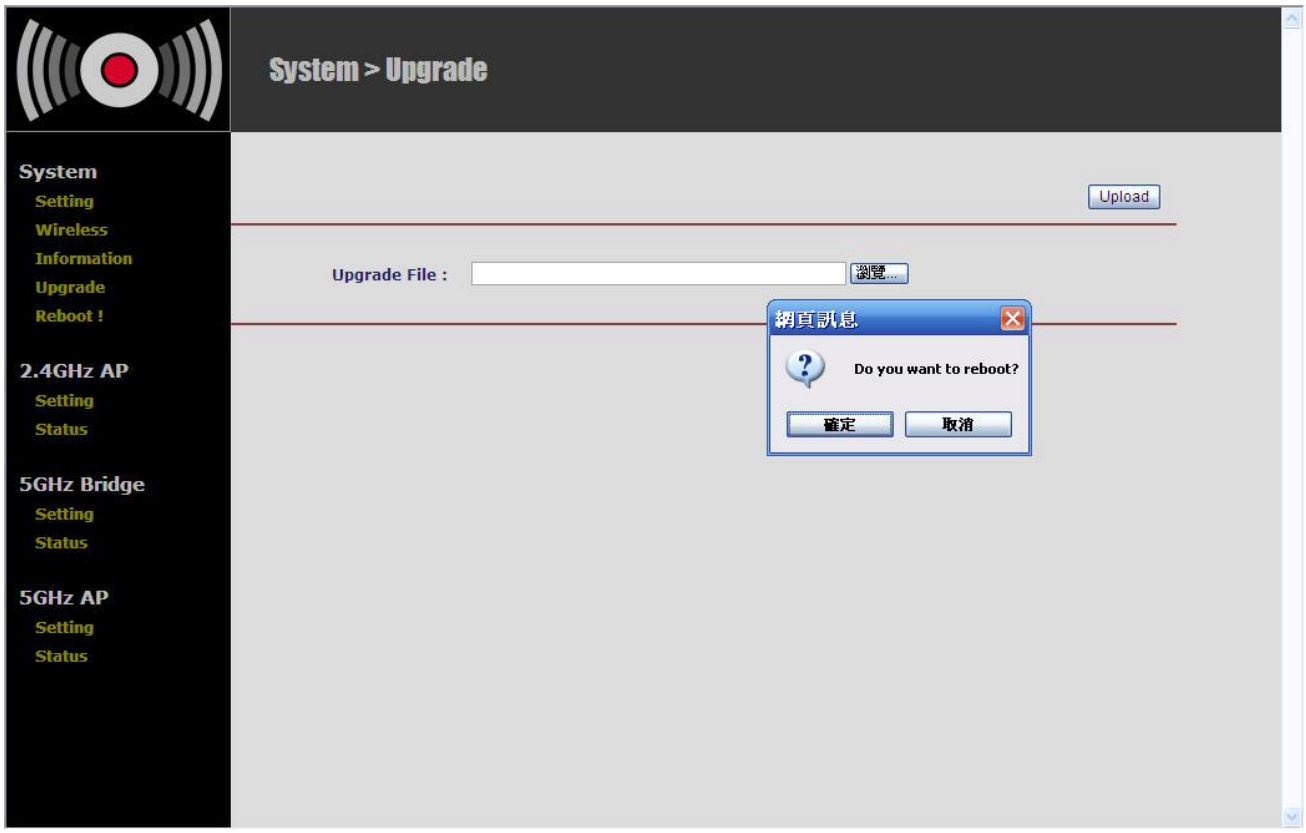
(b). In case network disruption happens during file uploading, system will still keep on running with current active firmware. You may perform the file upload again when network is back to normal.

1) Click **Browse** and select the firmware files to be uploaded from the PC.
2) Click **Upload**.
3) When uploading is completed, system will prompt a message asking if you wish to reboot.

4) Click **OK** to reboot the unit and make the new firmware to take effect.

2.4.4 Reboot

You can access reboot function by clicking **System** > **Reboot!**.

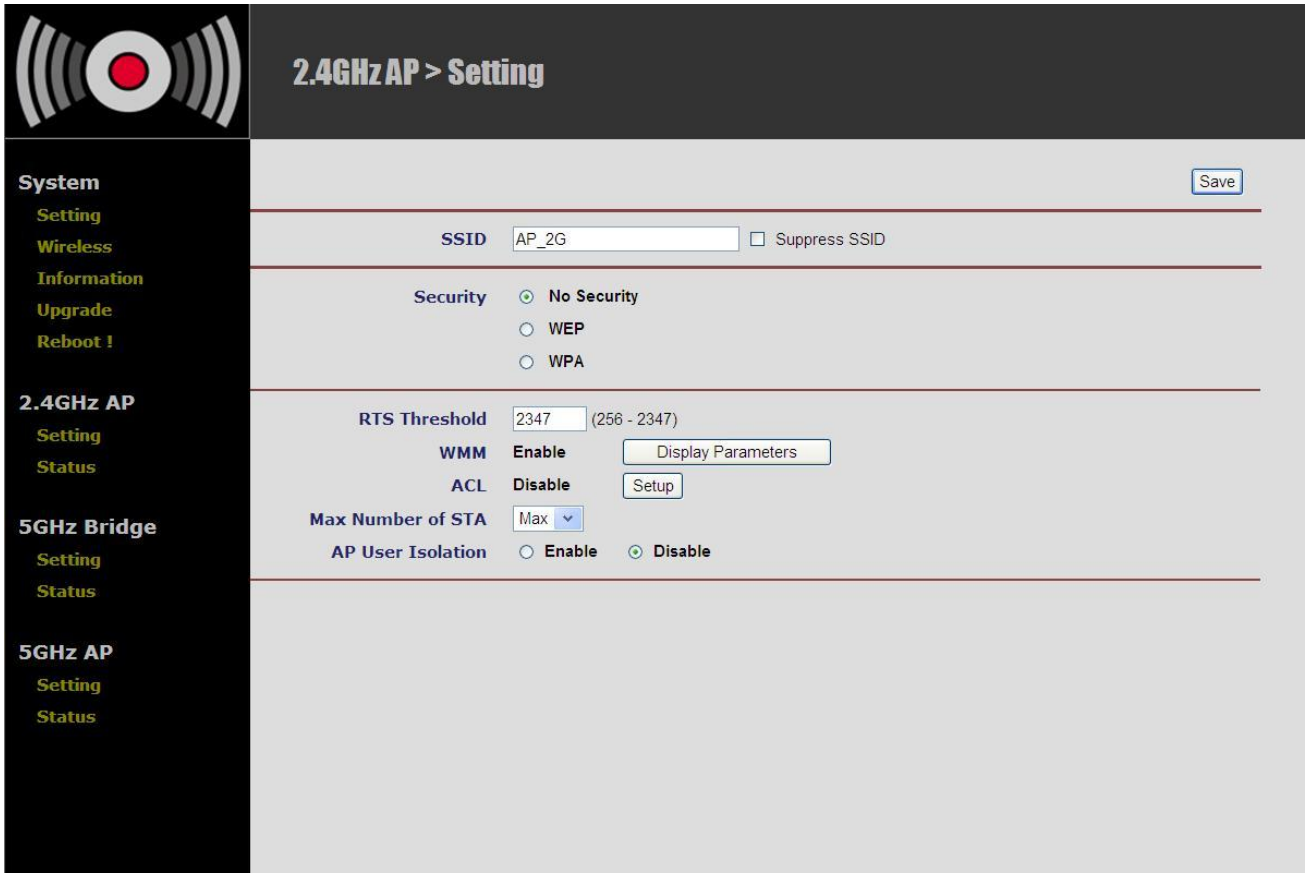


When starting reboot, system will prompt you a rebooting window. It takes at least 40-60 seconds to finish the reboot process.

3. Configure 2.4GHz AP

3.1 AP Configuration

This page can be accessed by clicking 2.4GHz **AP** > **Setting**



1) **SSID**

The SSID is the unique name shared among all points in a wireless network. The SSID must be identical for all points in the wireless network. It is case-sensitive and must not exceed 32 alphanumeric characters, which may be any keyboard character. Make sure this setting is the same for all points in your wireless network. For added security, you should change the SSID from the default **AP_2G** to a unique name. This option can make the SSID invisible from site survey tool. Enable this function only if you do not want the Access Point to be found by others.

2) **Suppress SSID**

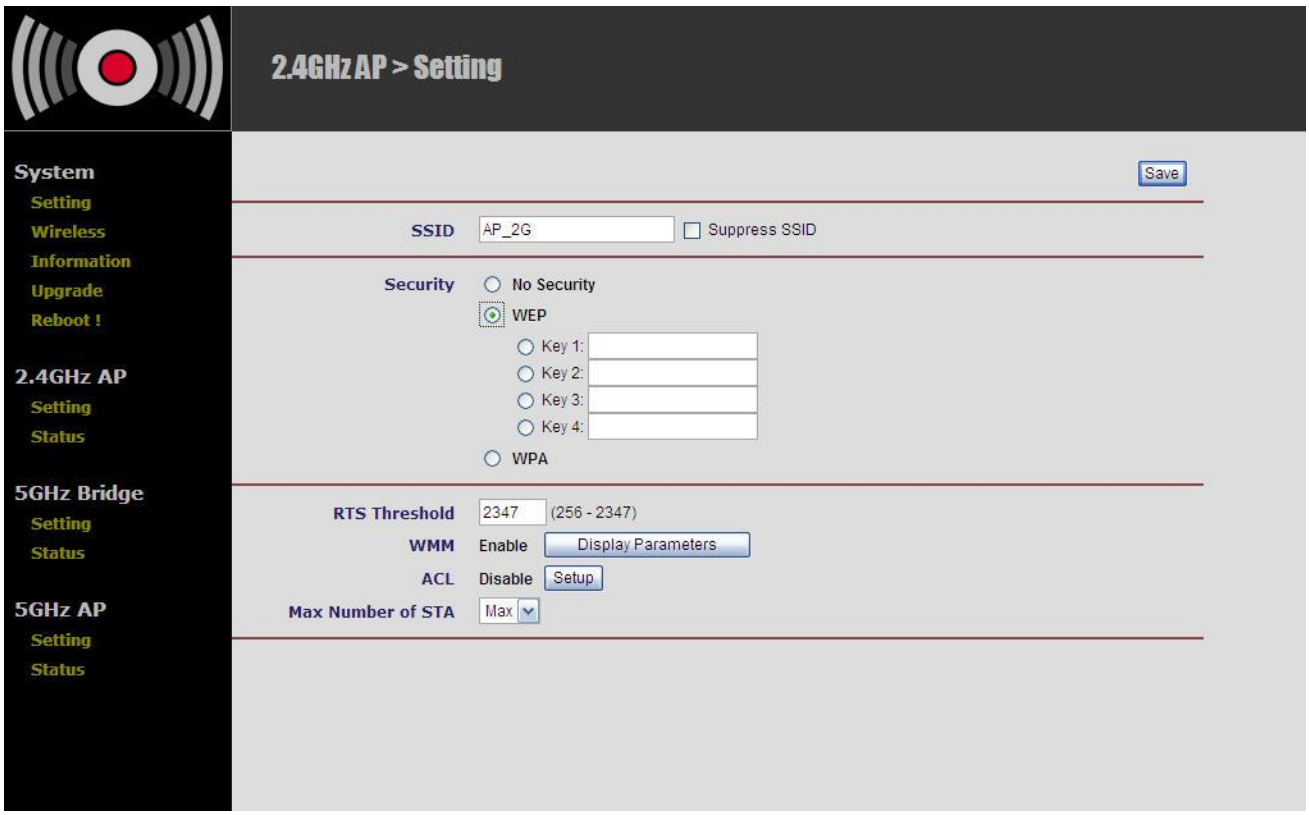
When you enable **Suppress SSID** function, SSID information will be removed from AP broadcast frame. Thus, only those stations aware of the SSID can associate with AP. The default setting is disabled.

3) **Security**

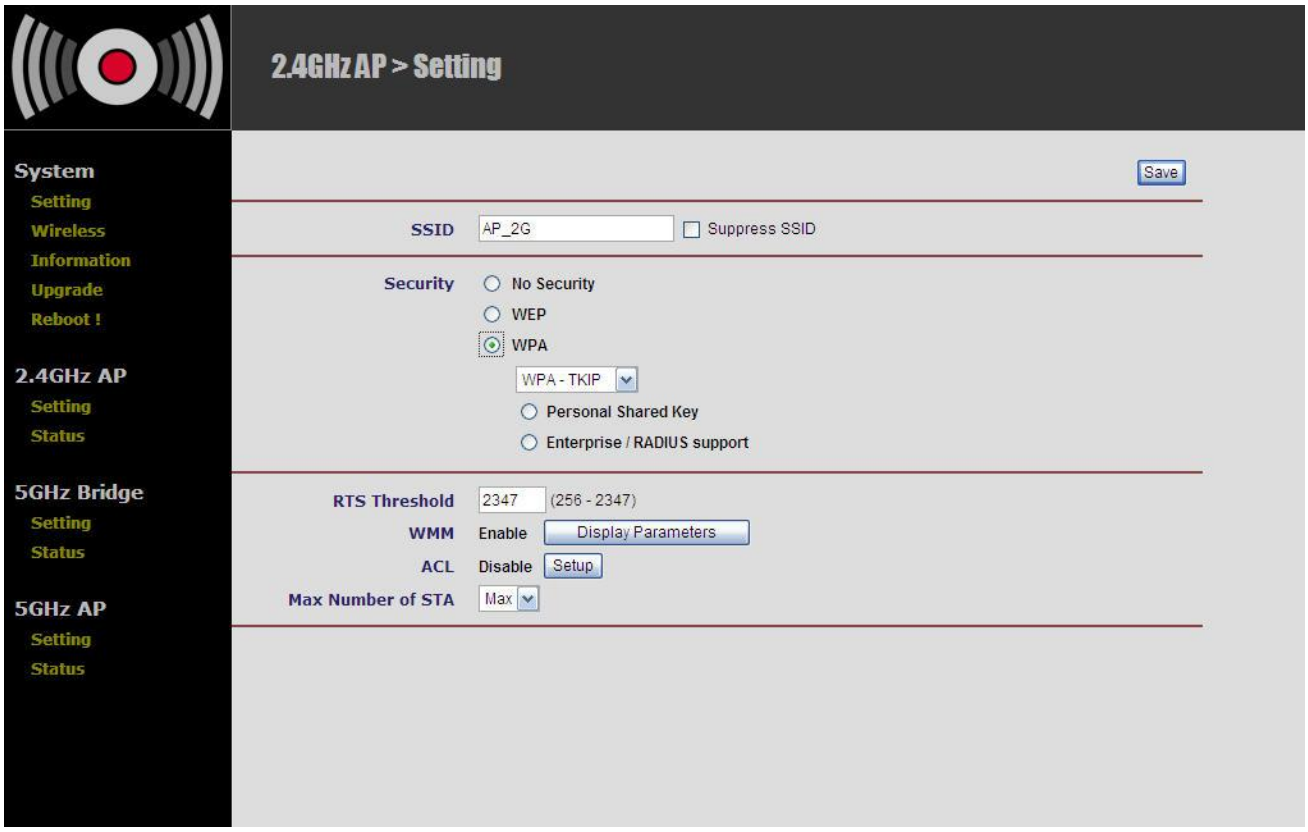
By default, the security is disabled (**No Security**). Refer to the next section to configure the

security features such as **WEP**, **WPA**, **WPA-PSK**, **WPA2** and **WPA2-PSK**.

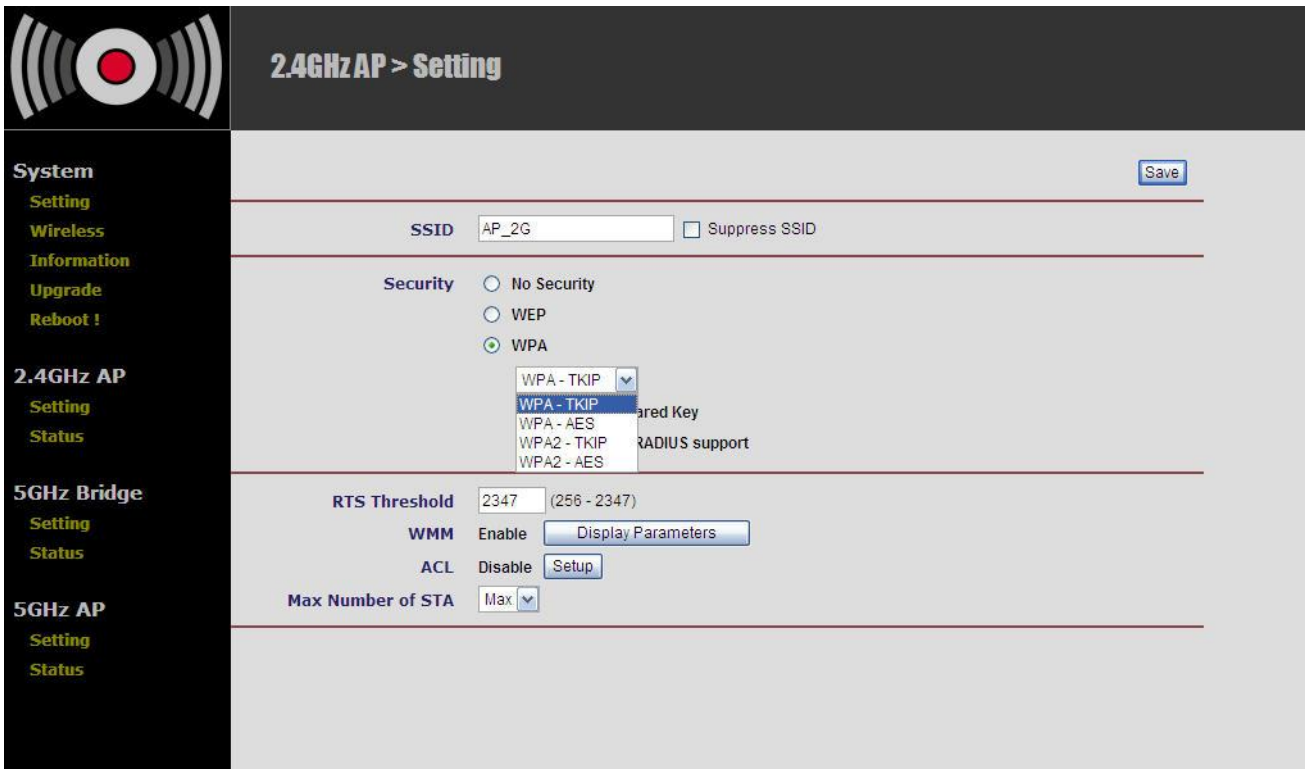
- Select **WEP** to enable the security mode.



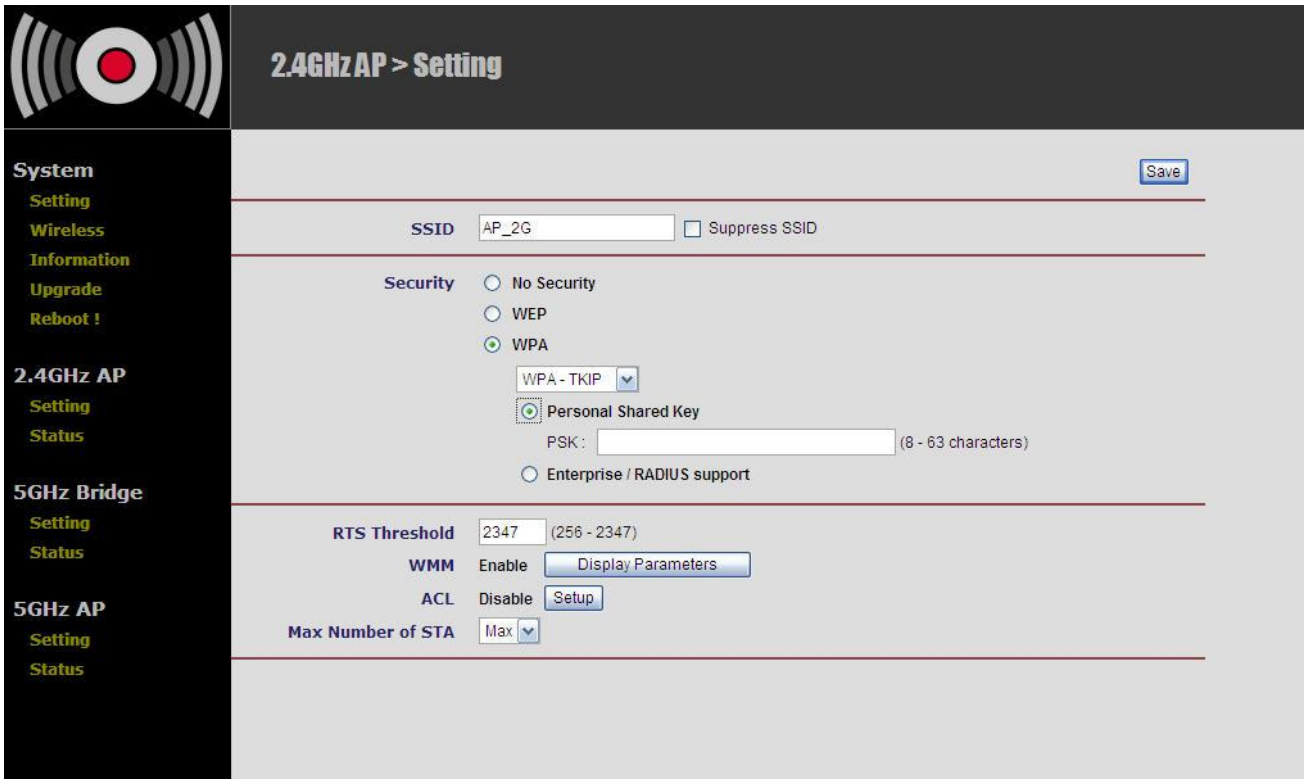
- **Key Entry Method**: Hexadecimal: The key must be hexadecimal (0-9, A-F).
- **Key Length:** For WEP encryption, the key length can be 10 HEX.
- **Encryption Key:** The WEP key can be in one of the following formats: 5 characters, 10 hex digits, 13 characters, or 26 hex digits.
- Select **WPA** to enable the security mode



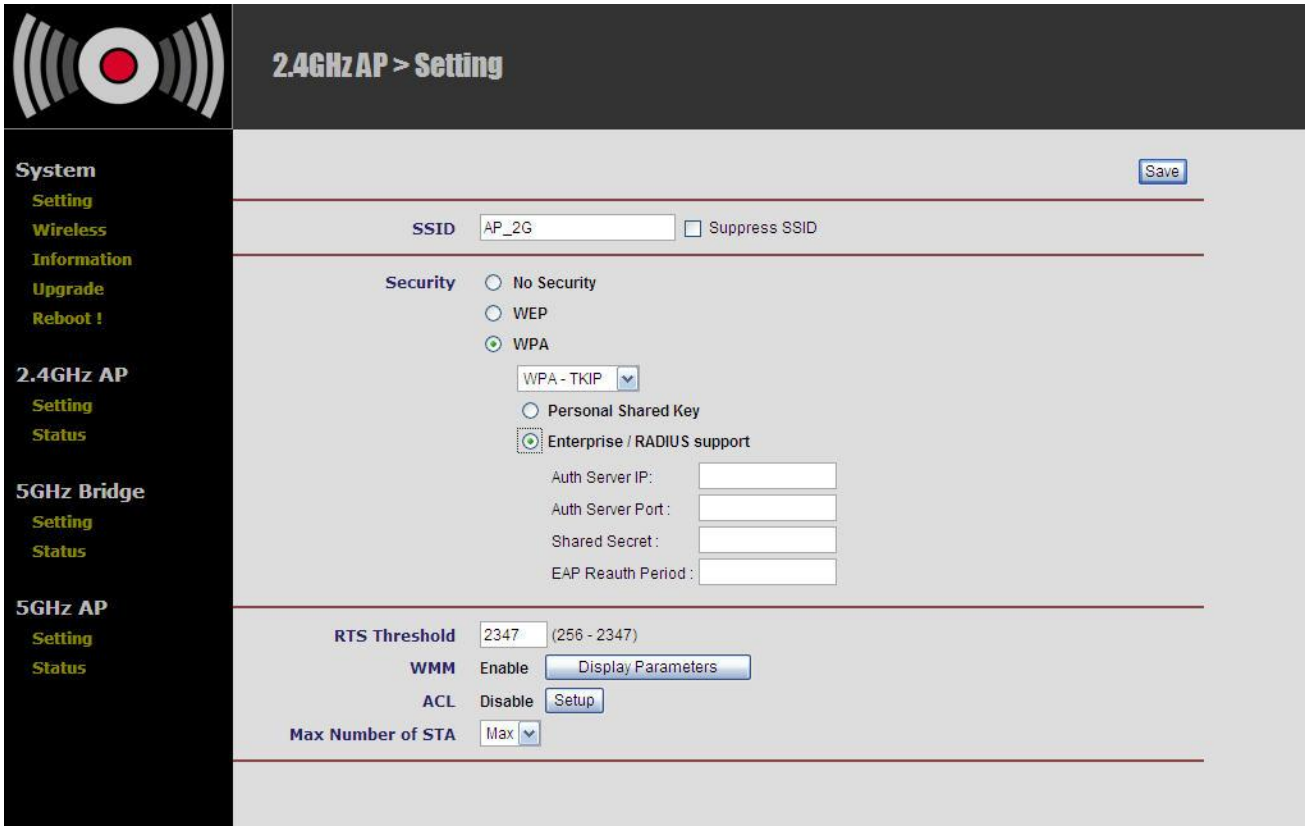
- Select the WPA mode according to your network plan



- **PSK:** he key is an ASCII string with length from 8 to 63 characters



- **Enterprise / RADIUS support:** enter the IP, port number and other related information to make the security controlled by your RADIUS server.



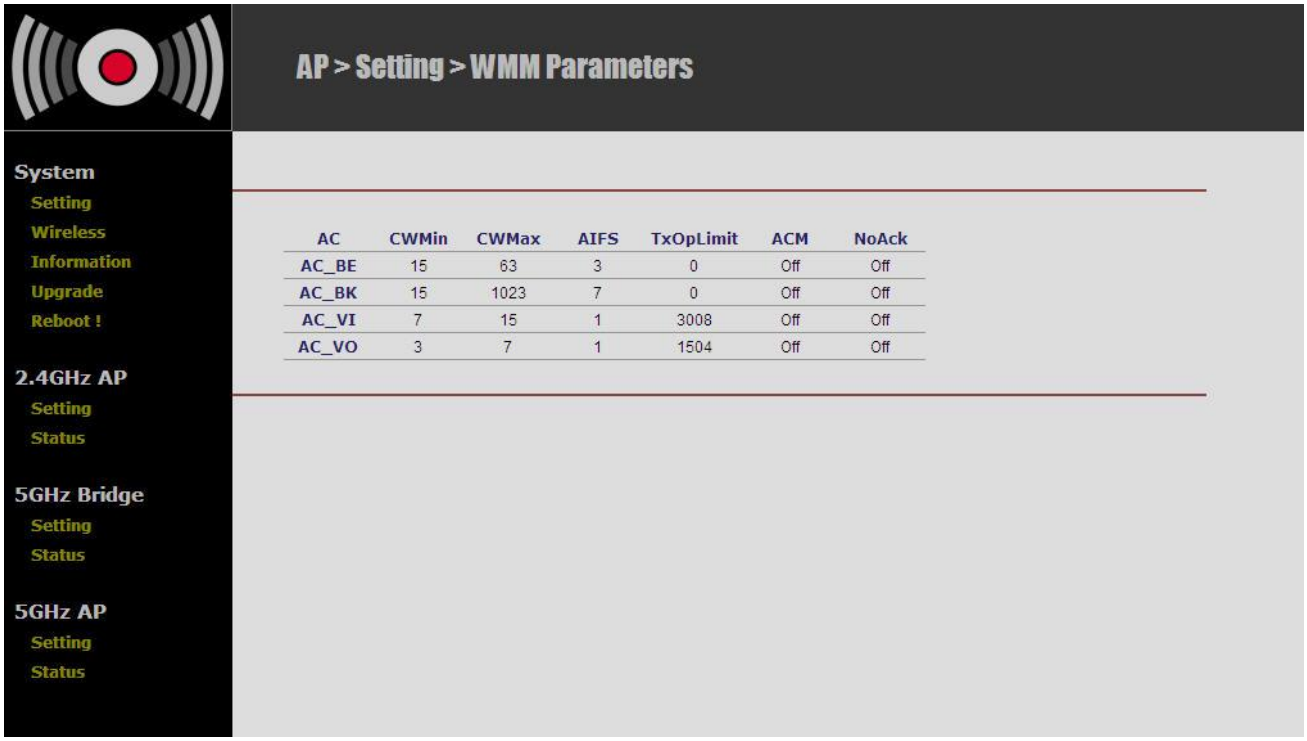
Note that it is required to have the same security setting between Bridges to communicate. To make changes take effect, click **Save** and **Reboot** when you finish all settings.

4) **RTS Threshold**

By default, the value is **2347**. This setting determines how large a packet can be before the Access Point coordinates transmission and reception to ensure efficient communication. This value should remain at its default setting of 2347. Should you encounter inconsistent data flow, only minor modifications are recommended.

5) **WMM**

Multimedia applications in a WiFi network require Quality of Service (QoS) functionality. The system default enabled WMM QoS feature, and it will prioritize traffic and optimizes the way shared network resources among different applications. It works well for data traffic from applications such as web browser, file transfer, or email, but it is inadequate for multimedia applications. Voice over Internet Protocol (VoIP), video streaming, and interactive gaming are highly sensitive to latency increases and throughput reductions, and required to enable QoS feature. The QoS parameters are default according to IEEE 802.11e as below:



Note:

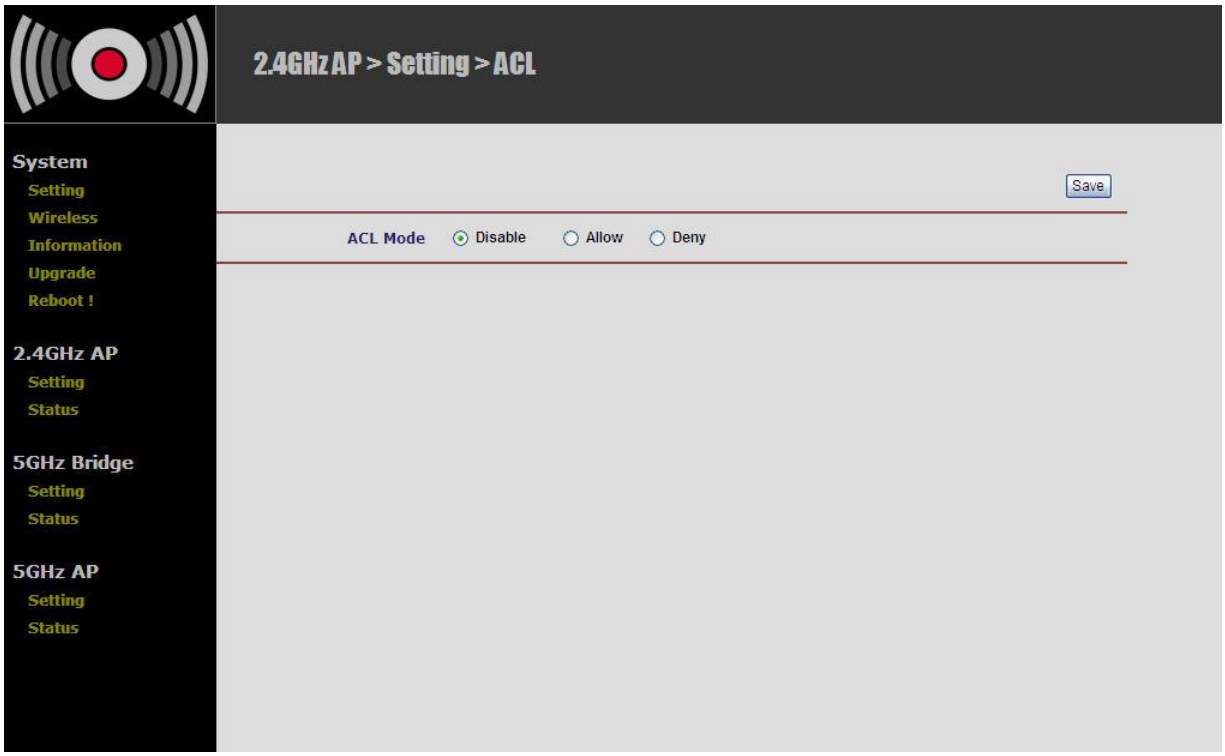
- AC_BE: Best effort packet

- AC_BK: Background packet
- AC_VI: Video packet
- AC_VO: Voice packet

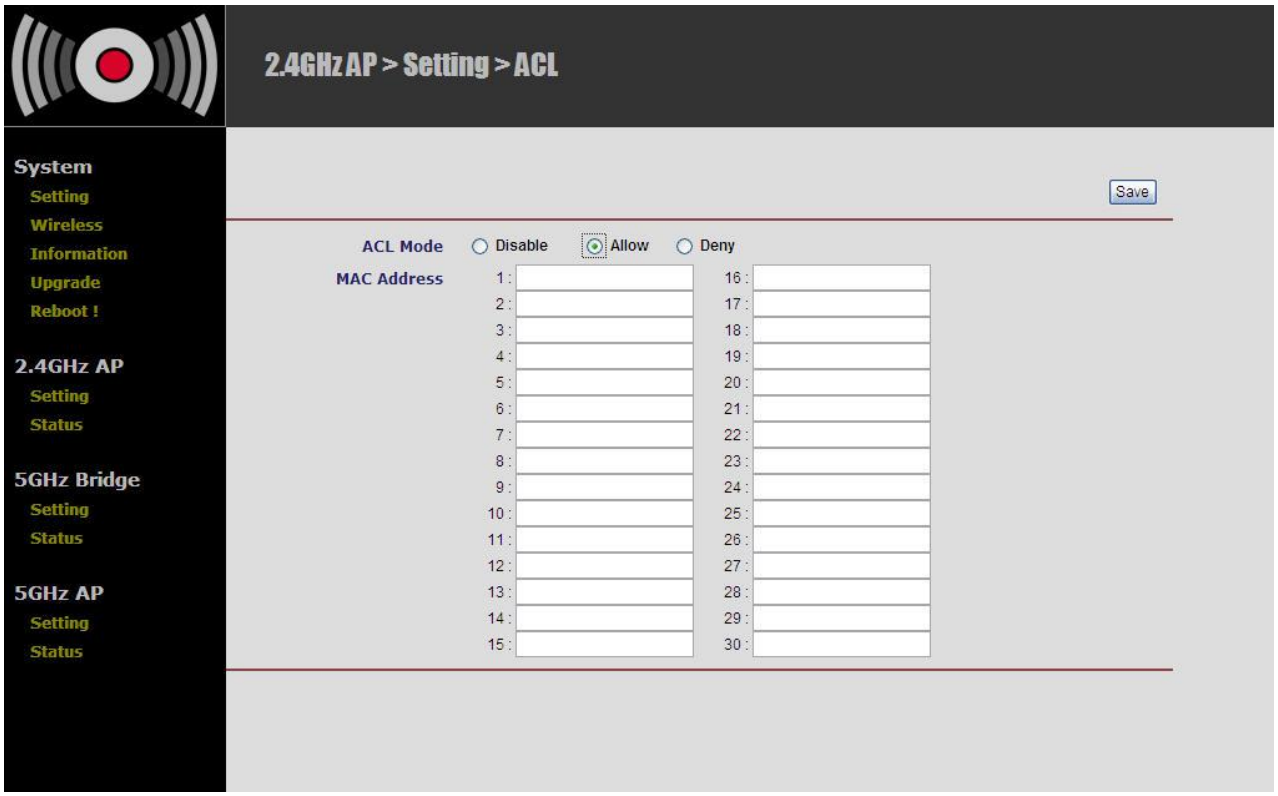
6) ACL (Access Control)

You may choose to **Disable**, **Allow**, or **Deny**. By selecting **Allow**, only the address listed in the table will have access to the network; all other clients will be blocked. On the other hand, select **Deny**, means only the listed MAC addresses will be blocked from accessing the network; all other clients will have access to the network.

MAC Address: Enter the MAC address.

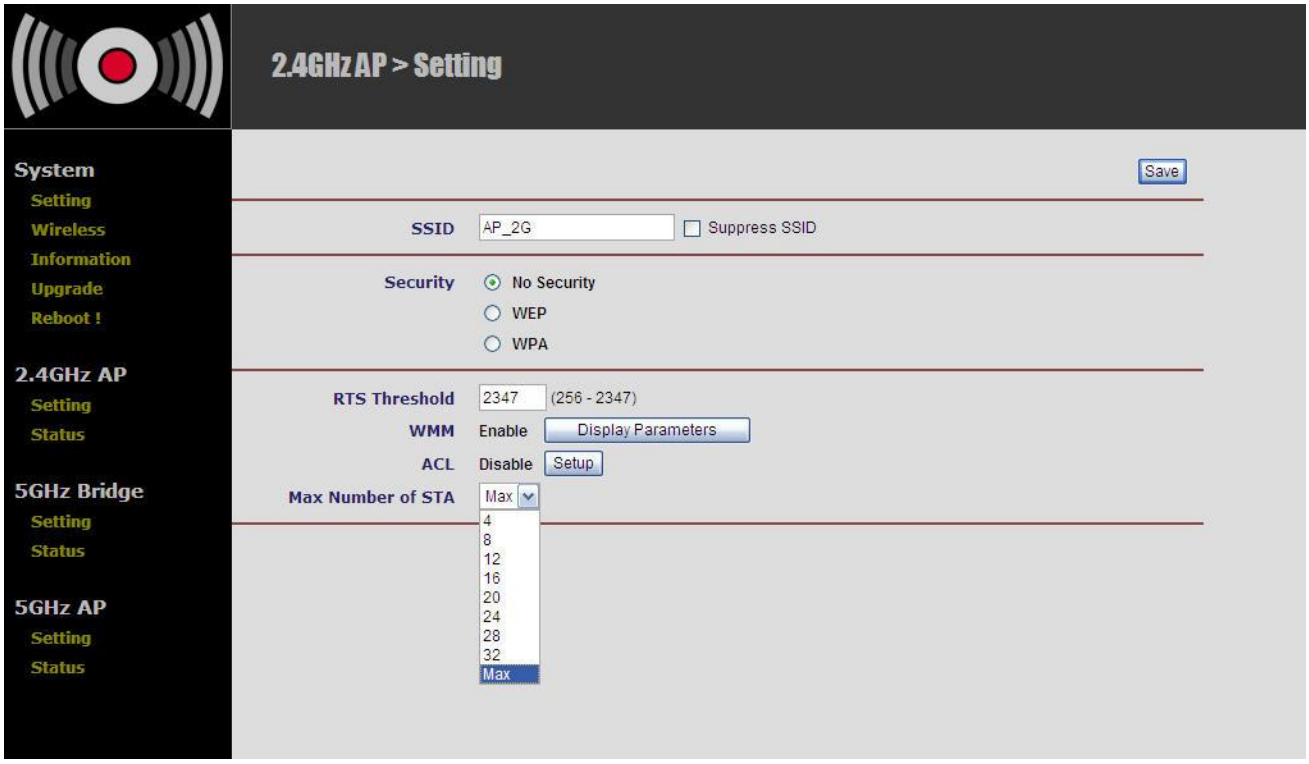


This table lists the blocked or allowed MAC addresses.

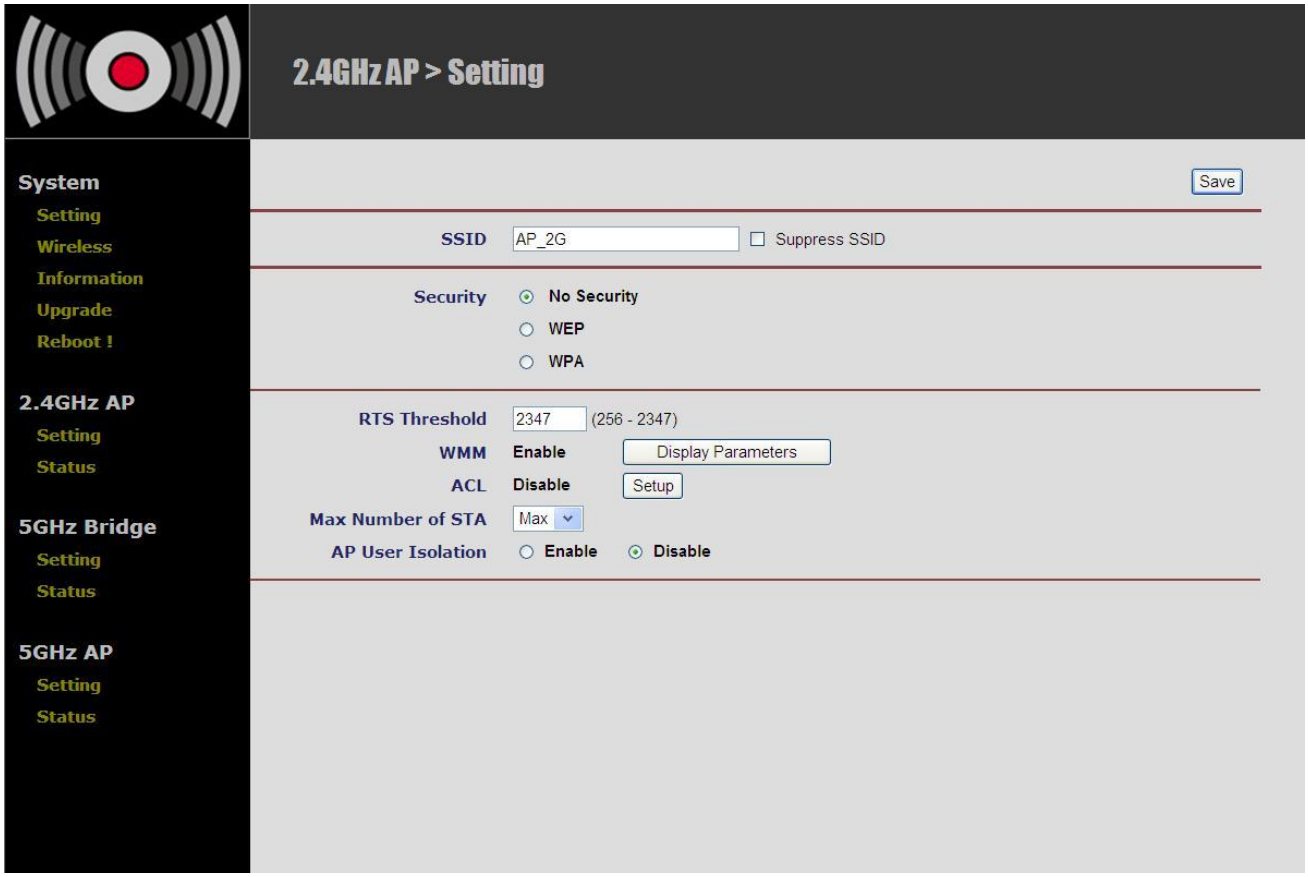


7) Max number of STA

You may decide the number of concurrent users that connected the this unit



8) **AP User Isolation**

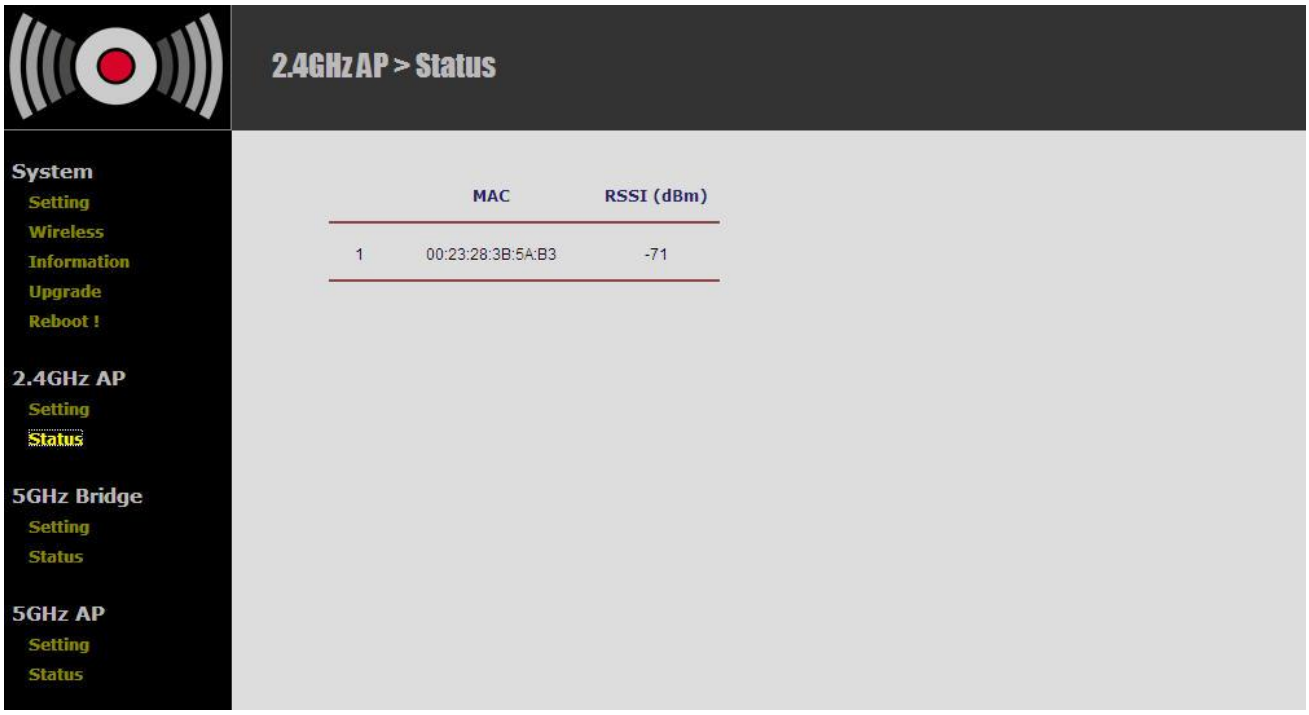


By default, it is **Disable**. You may enable it to prevent any connected users from viewing or overwriting others contents.

9) To make changes take effect, click **Save** and **Reboot** when you finish all settings.

3.2 AP Connection Status

This page can be accessed by clicking **2.4GHz AP** > **Status**

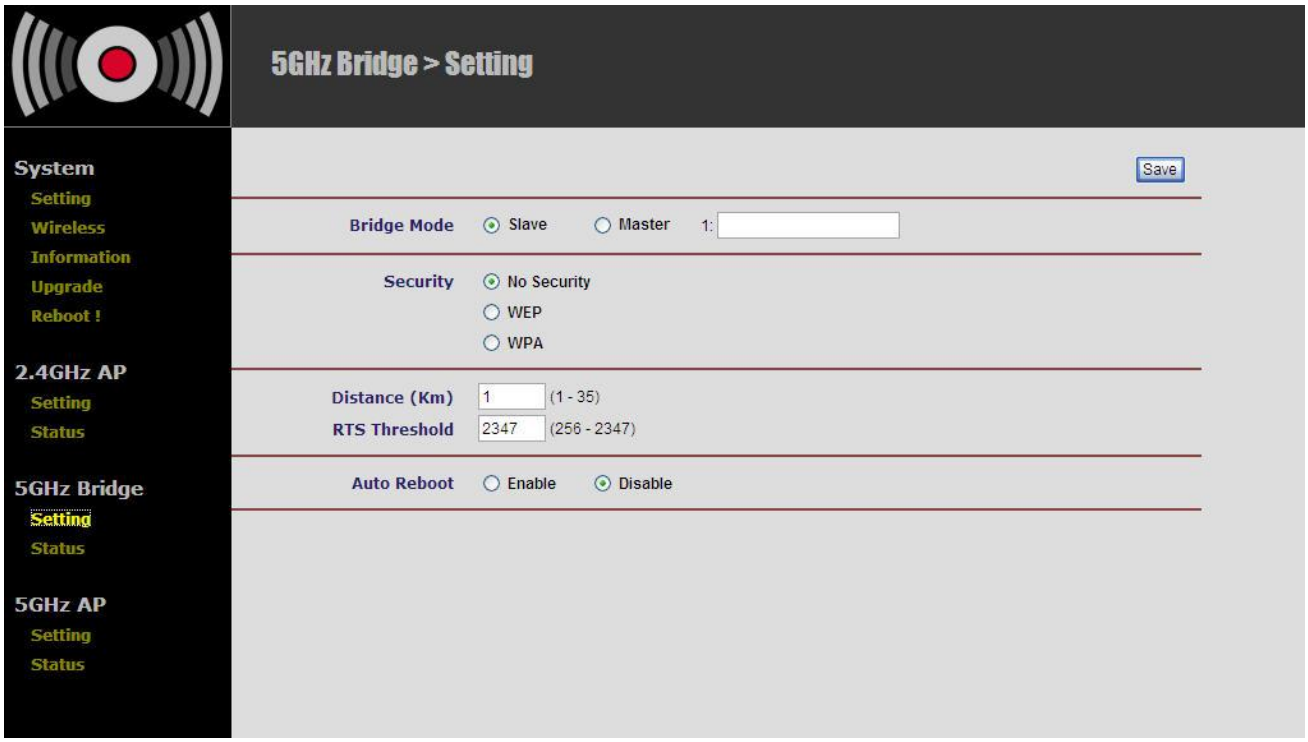


This page can help user to identify current devices that already associated to the AP. The MAC addresses and signal strength for each client will appear.

4. Configure 5GHz Bridge

4.1 Bridge Configuration

This page can be accessed by clicking **5GHz Bridge** > **Setting**.

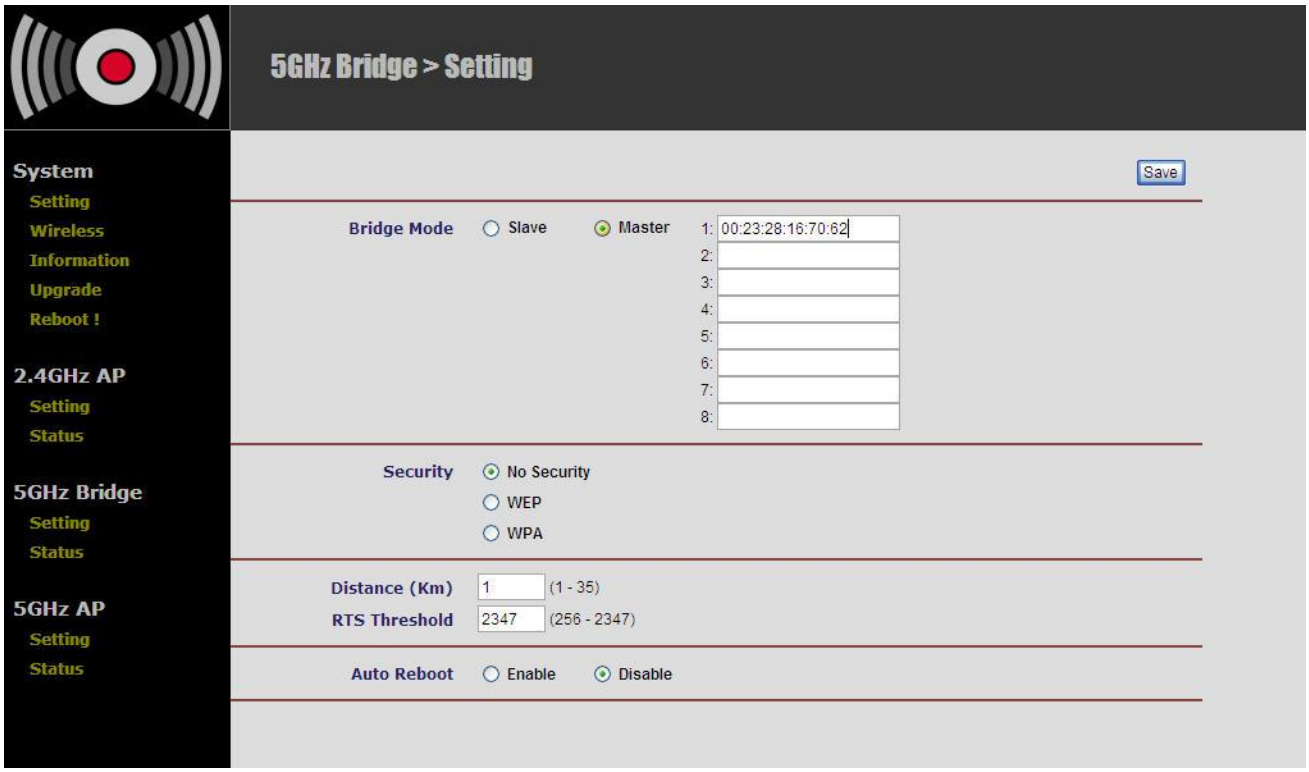


1) **Bridge Mode**

By default, it is in **Slave**. When **Master** is selected, the remote bridge mode shall set as Slave mode. One bridge network shall have only one outdoor unit in Master mode, and the others in Slave mode.

2) **Remote Bridge Setup**

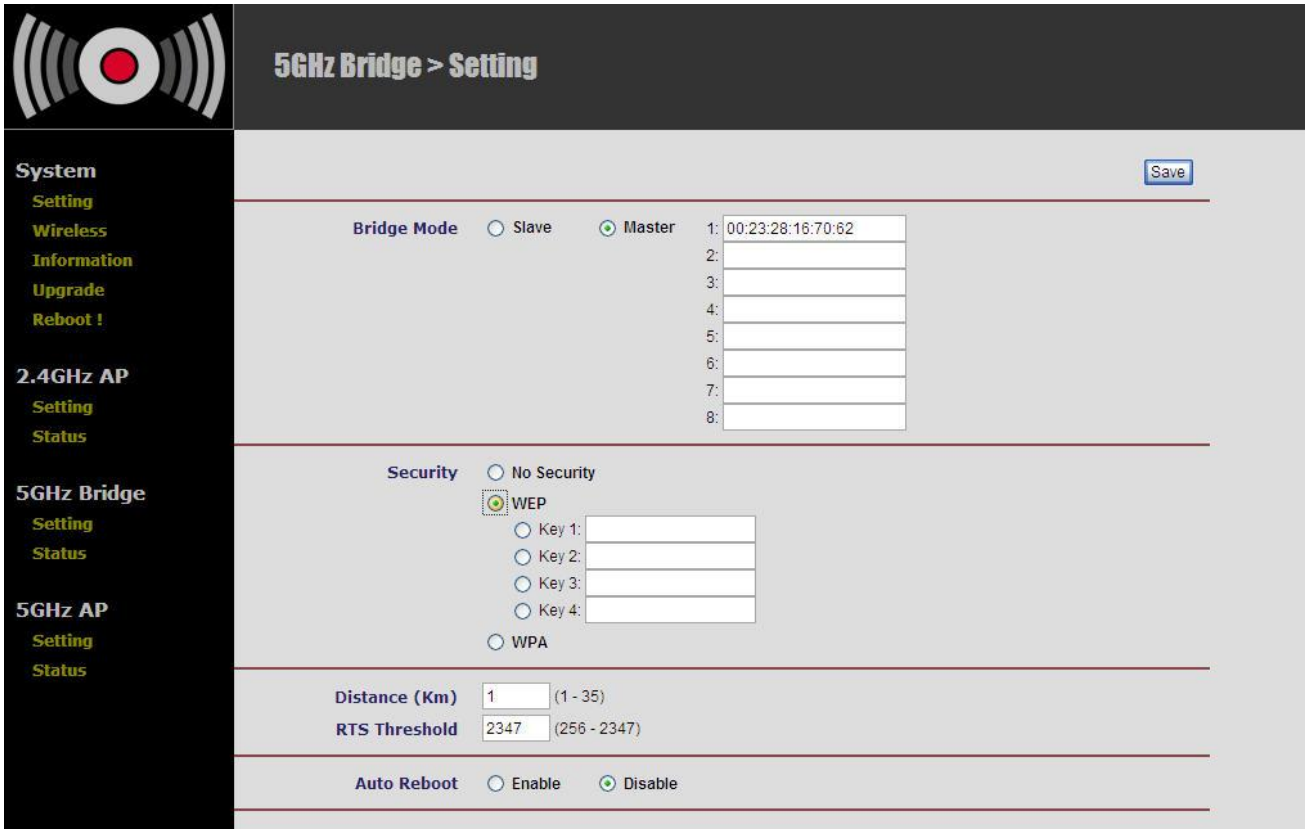
In order to establish the wireless link between Bridge Radios, the MAC address of remote Bridge(s) needs to be registered in the address filed. Enter the MAC address with format as xx:xx:xx:xx:xx:xx (x is the hexadecimal digit). Master Bridge Radio may accommodate up to 8 remote MAC addresses by the current firmware. In addition, Slave Bridge Radio supports only 1 MAC address which have to be the Master Bridge



3) **Security**

Please refer to page 23 for security setting.

WEP:



WPA:

- **Cypher Mode:** Select Cypher according to the security plan. TKIP or AES.
- **PSK:** The key is an ASCII string with length from 8 to 63 characters.

To make changes take effect, click **Save** and **Reboot** when you finish all settings

4) **Distance (Km)**

Enter the distance according to the longest link between the Master and Slaves in the network. The value needs to be greater than or equal to the real distance. The range is from 1Km to 35Km.

5) **RTS Threshold**

In order to prevent the transmission collision in a hidden nodes environment, Bridge may send a RTS (Request To Send) before transmitting the data frame from remote Bridge. You may define a threshold for those frame size greater than the threshold need to activate RTS mechanism. The valid range is from 256 to 2347. Set low value to this threshold may avoid collision, but the RTS frame would consume bandwidth.

Note: In Point to Multi-Point application, the transmission collision may be caused by hidden nodes affection in particular environment or network configuration. Setting smaller number of RTS threshold could alleviate the hidden nodes problem.

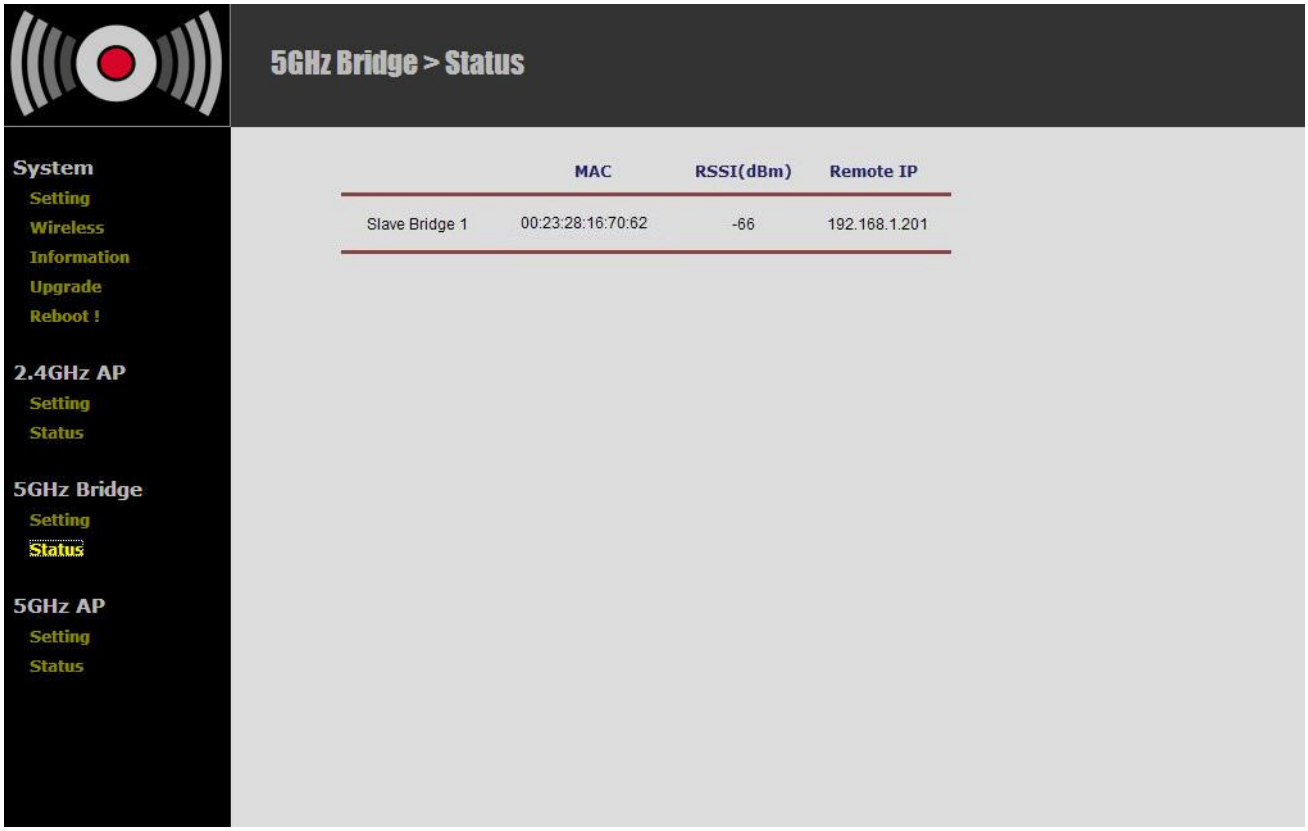
6) **Auto Reboot**

Default is **Disable**. When this function is enabled, near-end AP cannot receive ***alive message*** from far-end AP in a certain period. Then this function will perform automatically at near-end AP without notice. The ***alive message*** is communicated between near-end & far-end AP via 5GHz Bridge links.

7) To make changes take effect, click **Save** and **Reboot** when you finish all settings.

1)

4.2 Bridge Status

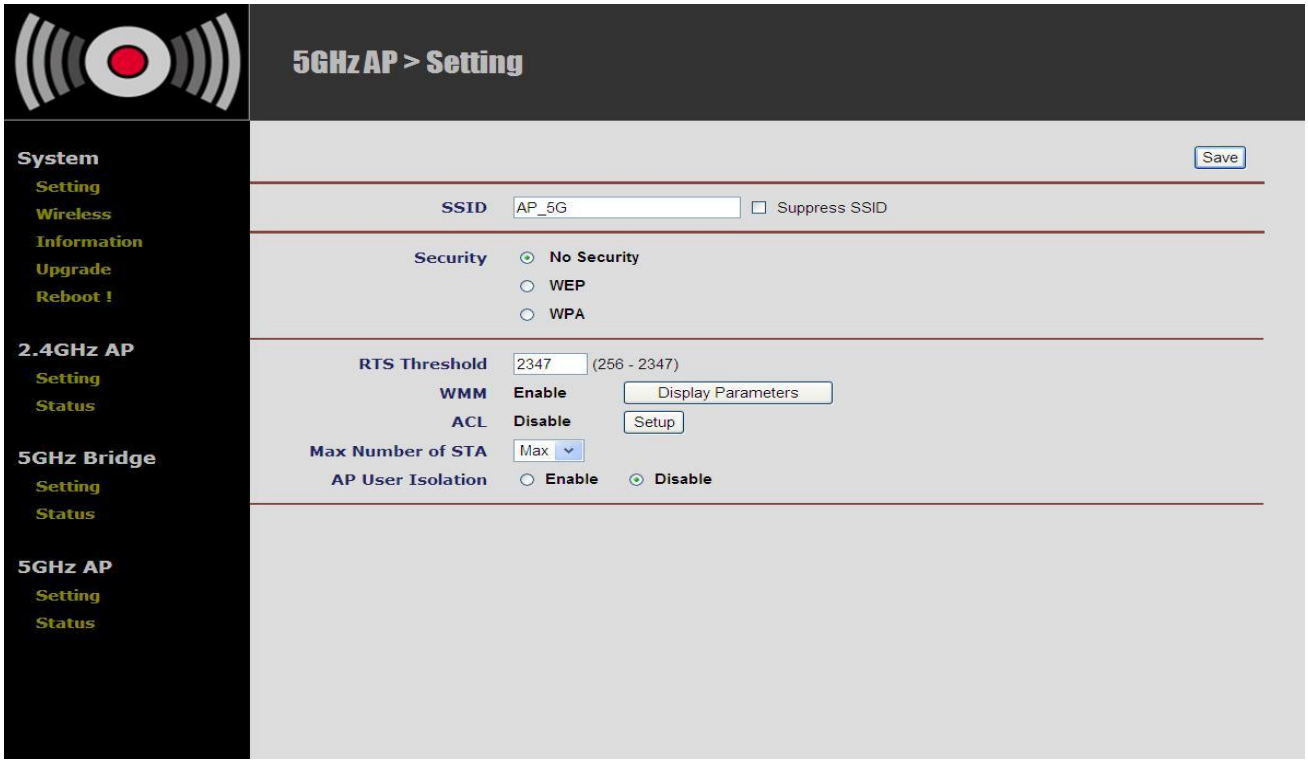


This page shows the local and remote Bridges and can be accessed by clicking **5GHz Bridge** > **Status**.

5. Configure 5Hz AP

5.1 AP Configuration

This page can be accessed by clicking **5GHz AP** > **Setting**.



1) **SSID**

The SSID is the unique name shared among all points in a wireless network. The SSID must be identical for all points in the wireless network. It is case-sensitive and must not exceed 32 alphanumeric characters, which may be any keyboard character. Make sure this setting is the same for all points in your wireless network. For added security, you should change the SSID from the default AP_2G to a unique name. This option can make the SSID invisible from site survey tool. Enable this function only if you do not want the Access Point to be found by others.

2) **Suppress SSID**

When you enable **Suppress SSID** function, SSID information will be removed from AP broadcast frame. Thus, only those stations aware of the SSID can associate with AP. The default setting is disabled.

3) **Security**

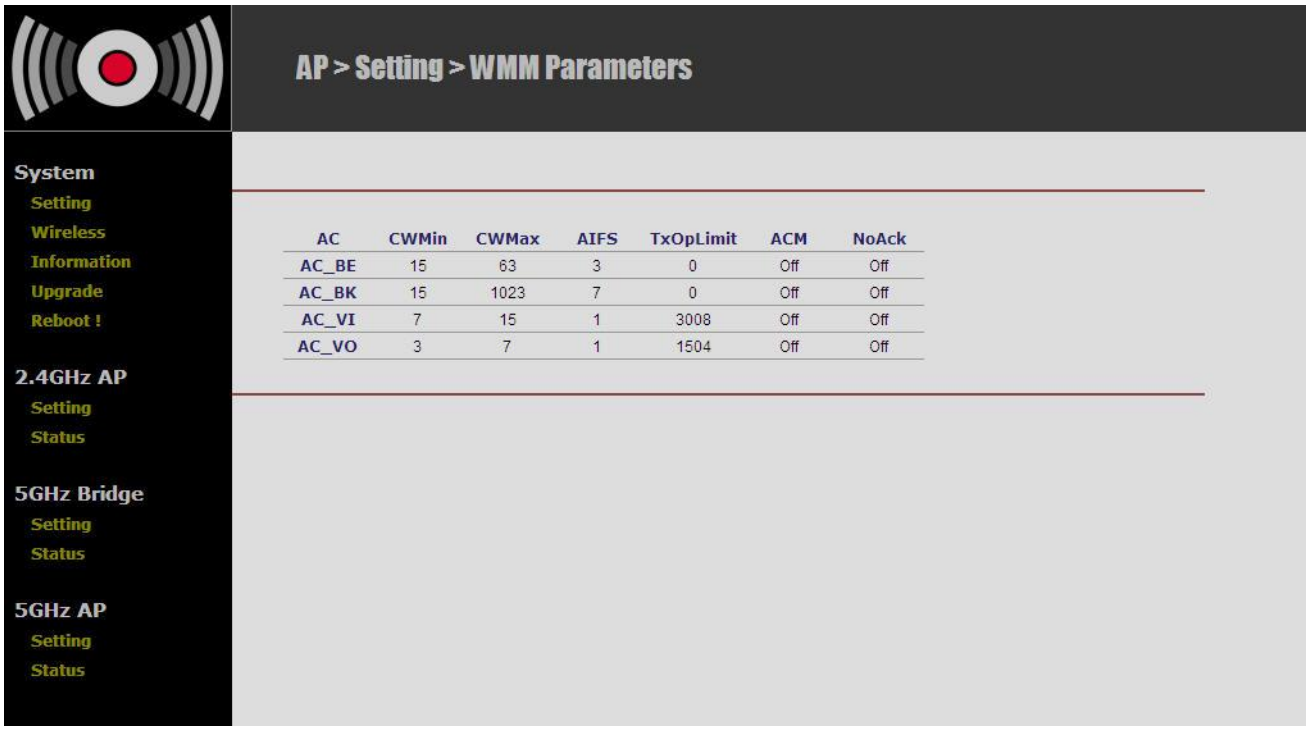
By default, the security is disabled (**No Security**). Refer to the next section to configure the security features such as **WEP**, **WPA**, **WPA-PSK**, **WPA2** and **WPA2-PSK**. For more information, please refer to page 26.

4) **RTS Threshold**

By default, the value is **2347**. This setting determines how large a packet can be before the Access Point coordinates transmission and reception to ensure efficient communication. This value should remain at its default setting of 2347. Should you encounter inconsistent data flow, only minor modifications are recommended.

5) **WMM**

Multimedia applications in a WiFi network require Quality of Service (QoS) functionality. The system default enabled WMM QoS feature, and it will prioritize traffic and optimizes the way shared network resources among different applications. It works well for data traffic from applications such as web browser, file transfer, or email, but it is inadequate for multimedia applications. Voice over Internet Protocol (VoIP), video streaming, and interactive gaming are highly sensitive to latency increases and throughput reductions, and required to enable QoS feature. The QoS parameters is default according to IEEE 802.11e as below.



Note:

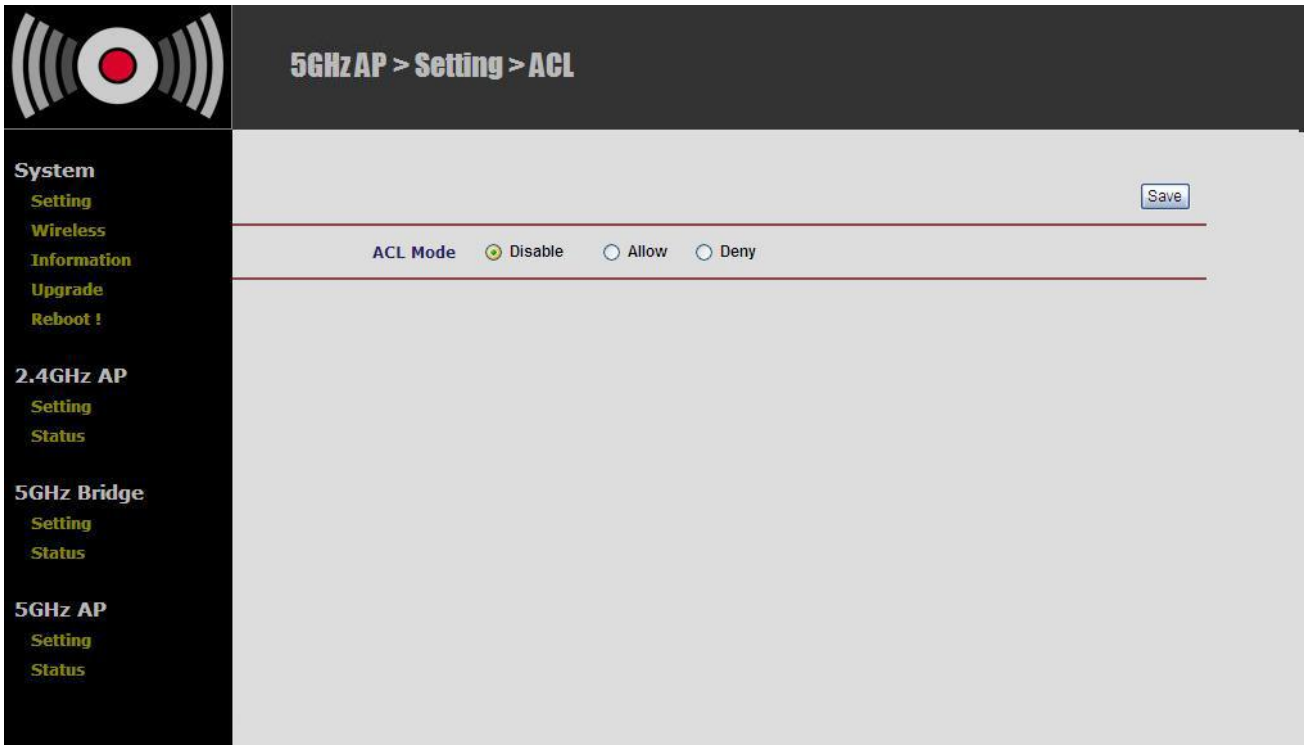
- AC_BE: Best effort packet
- AC_BK: Background packet
- AC_VI: Video packet
- AC_VO: Voice packet

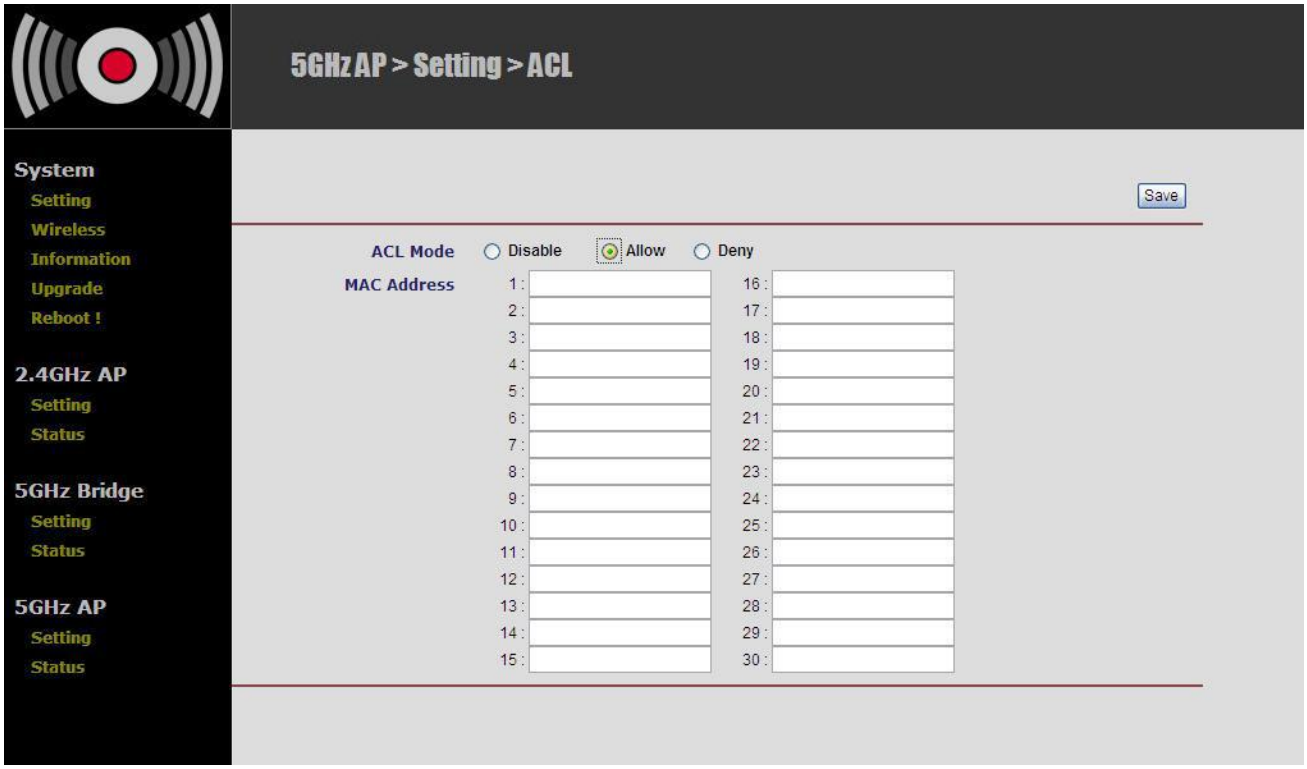
6) ACL (Access Control)

You may choose to **Disable**, **Allow**, or **Deny**. By selecting **Allow**, only the address listed in the table will have access to the network; all other clients will be blocked. On the other hand, select **Deny**, means only the listed MAC addresses will be blocked from accessing the network; all other clients will have access to the network.

MAC Address: Enter the MAC address.

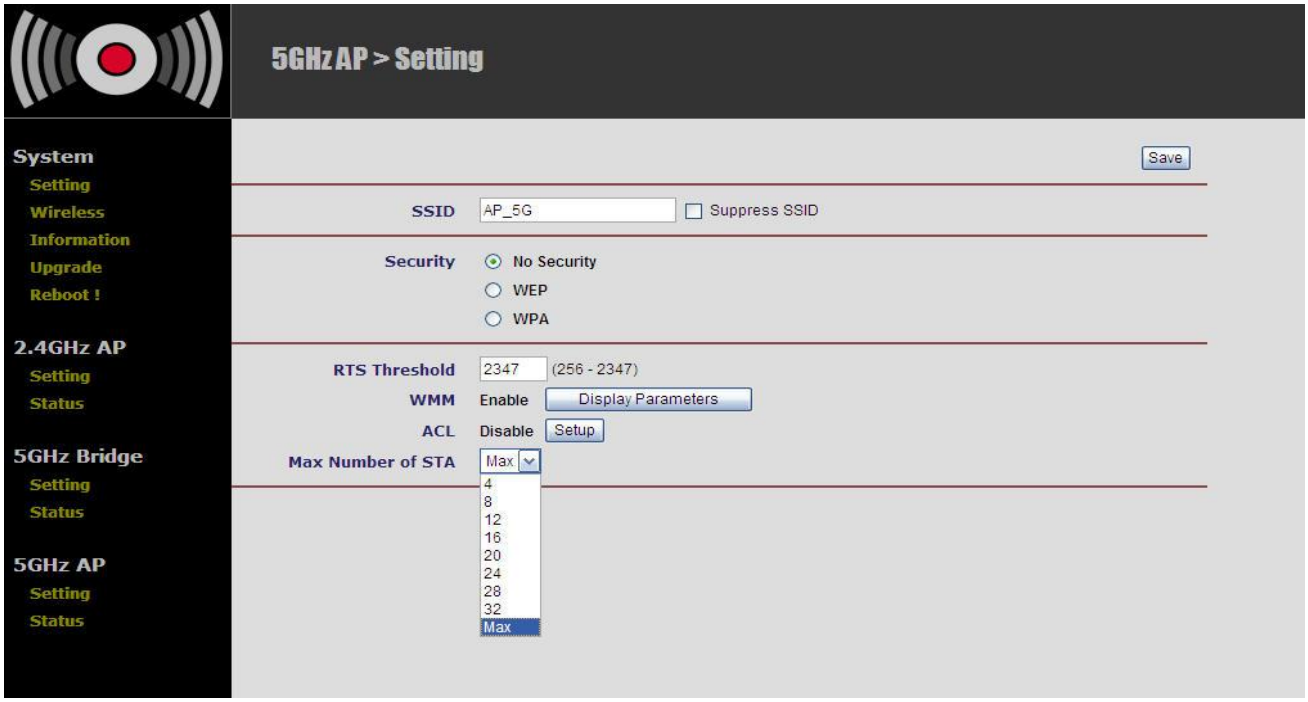
This table lists the blocked or allowed MAC addresses; you may delete selected MAC address.



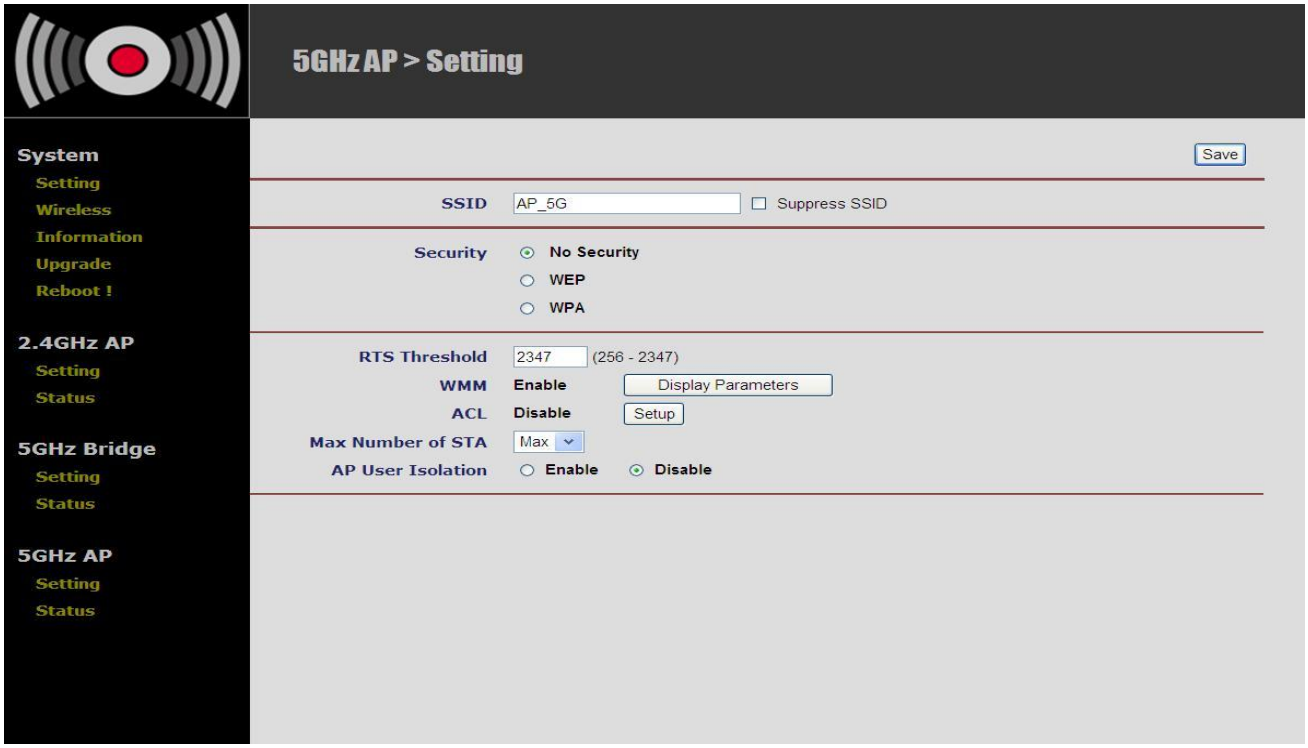


7) Max number of STA

You may decide the number of concurrent users that connected the this unit



8) AP User Isolation

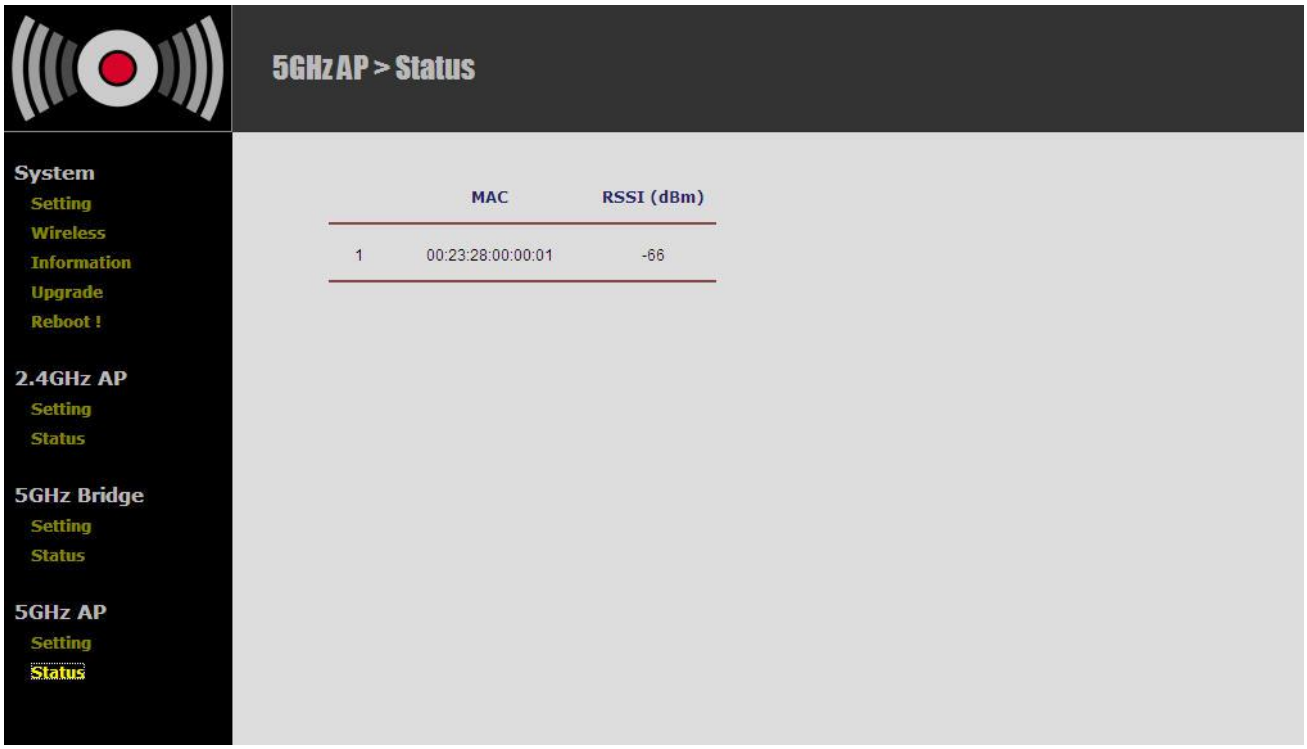


By default, it is **Disable**. You may enable it to prevent any connected users from viewing or overwriting others contents.

9) To make changes take effect, click **Save** and **Reboot** when you finish all settings.

5.2 5GHz AP Status

This page can be accessed by clicking 5GHz **AP** > **Status**.



This page can help user to identify current devices that already associated to the AP. The MAC addresses and signal strength for each client will appear.

6. Planning Linkage

6.1 Site Survey

You need to consider the following operating and environmental conditions when performing a site survey:

- **Data rates –** The sensitivity and the radio range are inversely proportional to data rates. Therefore, the maximum radio range is achieved at the lowest workable data rate, and a decrease in receiver threshold sensitivity occurs as the radio data rate increases.
- **Antenna type and placement** - Proper antenna configuration is a critical factor in maximizing radio range. As a general rule, the radio range increases in proportion to antenna gain and height.
- **Physical environment** - Clear or open areas provide better radio range than closed or filled areas. Clear line of sight (LOS) is required to establish a good and reliable wireless link.
- **Obstructions** - Metal shelving or a steel pillar can hinder devices. Avoid placing these devices in locations where those obstructions are between the sending and receiving antennas.

6.2 Planning Radio Path

For the wireless communication, the Line-of-Sight (LOS) will be the major issue overbuilding up the wireless link. This evaluated procedure is to reduce the obstructions and to avoid the multiple-path signal degrading the communication quality.

The first requirement is the Line-of-Sight (LOS) between the both side Antennas. The radio line-of-sight concept is the area along the radio linking path through which is the bulk of the radio signal power travels. The area is known as the first Fresnel Zone of the radio link. For the radio link, it should avoid to be affected by obstacles in this path, including the ground within 60% of the first Fresnel Zone.

The following figure illustrates the concept of a good radio line-of-sight.

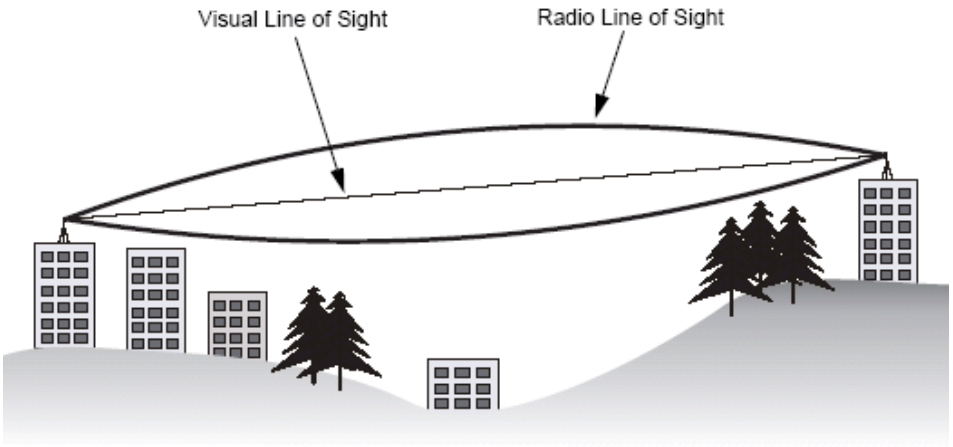


Figure 29. Line-of-Sight (LOS)

If there is any obstacle in the radio path, it may still be a radio link but the quality and the signal strength will be affected. Ensure the maximum clearance from objects on a path is important to locate the antennas and the height. For the long distance links, the radio signals might be lost partially due to the non-LOS issue.

As we setup the radio path for the wireless bridge link, it needs to consider these factors:

- Avoid any partial line-of-sight between the antennas.
- Be aware of trees that may be near the path or obstruct the path.
- Make sure there is enough clearance from buildings and there is no any building or construction blocking the path.
- Check the land topology between the antennas using topographical maps, aerial photos, or even satellite image data.
- Avoid a path that may have the temporary blockage due to the moving objects, such as cars, trains, or aircrafts.

Note: For the wireless link less than 500m, the IEEE 802.11a radio signal will tolerate some obstacles in the path and may not even require a visual line of sight between the antennas.

6.2.1 Antenna Height

The reliable wireless link usually depends on the both sides antennas for a clear radio line of sight. The minimum height is determined by the link distance, obstacles that may be in the path, topology of the terrain, and the curvature of the earth (for links over 2 miles). For the long distance links, the mast or the pole may need to be constructed to attain the minimum required height. The following table is for you to estimate the required minimum clearance above the ground or path obstruction.

Total Link Distance	Max Clearance for 60% of First Fresnel Zone at 5.8 GHz	Approximate Clearance for Earth Curvature	Total Clearance Required at Mid-point of Link
0.25 mile (402 m)	4.5 ft (1.4 m)	0	4.5 ft (1.4 m)
0.5 mile (805 m)	6.4 ft (1.95 m)	0	6.4 ft (1.95 m)
1 mile (1.6 km)	9 ft (2.7 m)	0	9 ft (2.7 m)
2 miles (3.2 km)	12.7 ft (3.9 m)	1 ft (0.3 m)	13.7 ft (4.2 m)
3 miles (4.8 km)	15.6 ft (4.8 m)	2 ft (0.6 m)	17.6 ft (5.4 m)
4 miles (6.4 km)	18 ft (5.5 m)	3 ft (0.9 m)	21 ft (6.4 m)
5 miles (8 km)	20 ft (6.1 m)	4 ft (1.2 m)	24 ft (7.3 m)
7 miles (11.3 km)	24 ft (7.3 m)	8 ft (2.4 m)	32 ft (9.7 m)
9 miles (14.5 km)	27 ft (8.2 m)	14 ft (4.3 m)	41 ft (12.5 m)
12 miles (19.3 km)	31 ft (9.5 m)	24 ft (7.3 m)	55 ft (16.8 m)

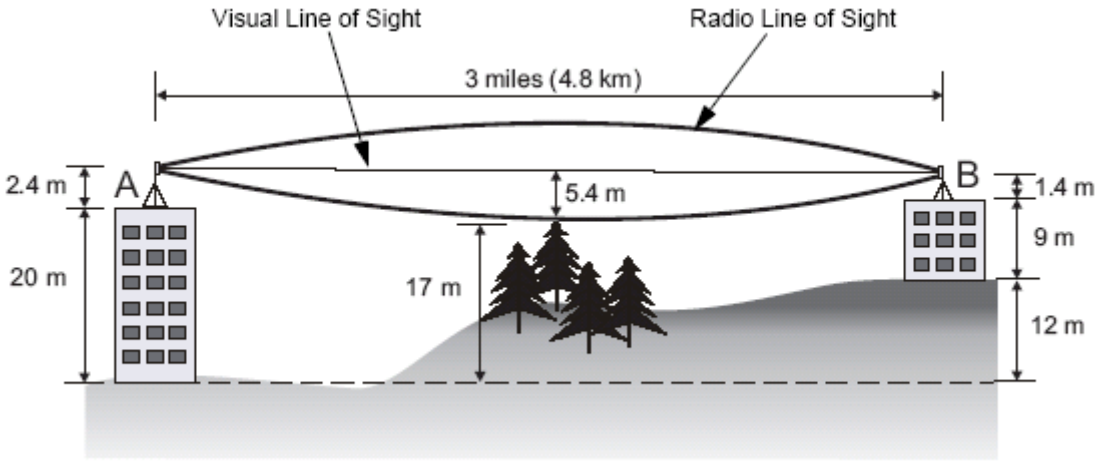


Figure 30. Antenna height

For example, the wireless link between the building A and the building B is located three miles (4.8 km) away. There is a tree-covered hill in middle. From the table above, it can be seen that for a three-mile link and the object clearance required at the mid-point is 5.4 m (17.6 ft). The tree-covered hill height is at an elevation of 17 m (56 ft), so the antennas link on both sides need to be at least 22.4 m (73 ft) high. The building A is six stories high or 20 m (66 ft), so the mast or pole with 2.4 m (7.9 ft) must be constructed on its roof to meet the required antenna height. The building B is only three stories high or 9 m (30 ft) but it is located at an elevation that is 12 m (39 ft) higher than the building A. A mast or pole is required to mount an antenna at the required height 1.4 m (4.6ft) on the roof of building B.

6.3 Data-rate

The following table provides a range and recommended data rate guideline using the build-in 16dBi antenna as examples. User can base on the targeted system performance to select an appropriate antenna that can support the planned data rate for the application. For example, the bridge with the build-in 16dBi antenna (when purchased with build-in antenna option) at both ends could operate well with 6 Mbps data rate up to 25 Km.

Data Rate	Recommended Maximum Distance (Build-In 16dBi Antenna) @5850MHz, 10dB system margin
6 Mbps	25 Km
54 Mbps	2.2 Km
MCS0~3	25 Km
MCS 8~11	12.8 Km
MCS 7	1.4 Km
MCS 15	0.9 Km

Figure 31 Recommended Maximum Distance with 16dBi Built-in Antenna